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EXTRATHECAL HÆMANGIOLIPOMAS OF THE SPINAL CANAL

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Two cases of extrathecal hæmangiolipoma of the thoracic region of the spinal canal are reported. On account of the rare occurrence of such tumours we have considered that they are worthy of description and record.

CASE REPORTS

Case 1.—A. P., female, aged 51 years. Housewife. Admitted to University College Hospital on Dec. 13, 1947 (referred later to us by Dr. K. E. Harris).

The patient was well until 1938, when she developed intermittent weakness, numbness, and heaviness of the lower limbs, lasting a few hours at a time. This persisted for some months, until in 1939 she noticed hesitancy of micturition, which increased to complete retention of urine requiring catheterization. The symptoms in her legs increased in severity at the same time.

She was admitted to a London hospital, where a mild spastic paraplegia was found, with sensory loss below D.6. A myelogram showed a doubtful block at D.7.

There were no signs of involvement of the cranial nerves or upper limbs. The cerebrospinal fluid and blood examinations were normal. A diagnosis of disseminated sclerosis was made.

She recovered spontaneously and completely and remained well until 1945, when she had another similar attack from which she recovered in three months without treatment. In 1946 she again relapsed and recovered spontaneously.

In June, 1947, she had yet another attack which began with pain between the shoulder-blades, followed by weakness and numbness of both legs and retention of urine. This attack was more severe than the previous ones and she became bedridden. She was admitted to another hospital, where the findings were substantially similar to those of 1939. The diagnosis of disseminated sclerosis was confirmed, and she was treated symptomatically. She was admitted to University College Hospital in December, 1947, her condition having further deteriorated.

ON EXAMINATION.—A well-built, somewhat obese woman with no abnormal physical signs in the cardiovascular, respiratory, or alimentary systems.

Central Nervous System.—

1. Mentality, speech, and response to questions were normal.

2. *Cranial nerves*: No abnormality detected. (The optic disks were free from temporal pallor, and there was no nystagmus.)

3. *Motor system*: (*a*) Upper limbs—No motor or sensory abnormality detected. The reflexes were symmetrically increased. (*b*) Lower limbs—Gross weakness of all segments symmetrically. Spastic paraplegia with flexor spasms. Reflexes all increased, with knee and ankle clonus. Bilateral extensor plantar responses. (*c*) The abdominal reflexes were absent.

4. *Sensation* (*Fig.* 1): A sensory level to pain and light touch which began at D.4 and became definite about D.7 was noted. Below this level there was still some appreciation, but all forms of sensation were markedly impaired.

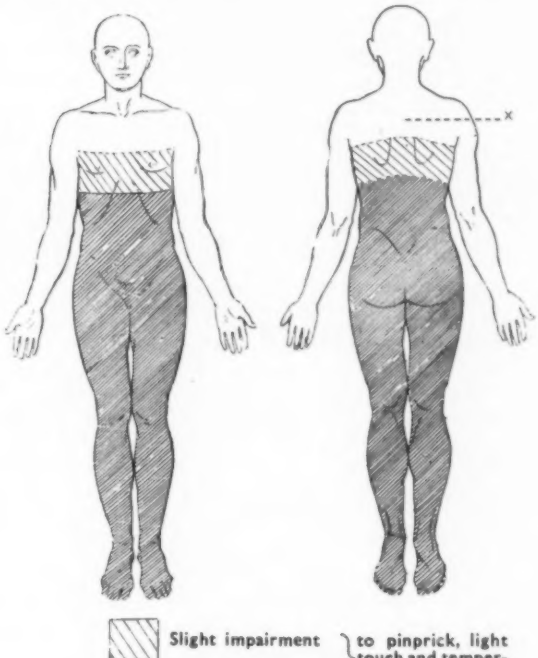

FIG. 1.—Sensory loss in *Case* 1. X, Myelogram shows partial block (D.3).

5. *Sphincters*: Retention of urine with overflow. Occasional incontinence of fæces.

6. *Gait*: Unable to stand or walk.

INVESTIGATIONS.—

a. Radiological examination of spine. No abnormality found. (Residual globules of opaque medium in lumbar sac, presumably from myelography in 1939.)

b. Blood-count normal.

c. Urine: mixed infection.

d. Lumbar cerebrospinal fluid: clear, colourless fluid. Manometry normal. No clot. No cells. Chemistry: Protein 80 mg./100 ml.; Chlorides 730 mg./100 ml.; Sugar normal. Globulin negative. Lange 0000000 000. Wassermann negative.

e. Cisternal myelography (1·5 ml. pantopaque): The fluid passed readily through the cervical region but tended to become fragmented in the region of D.3–4 before

passing down on further elevation of the patient to the erect position. At the conclusion a small number of minute globules were held up permanently at the level of D.3 spinous process.

A thoracic laminectomy was decided upon in view of the severe spastic paraplegia, the raised cerebrospinal fluid protein, and the rather indefinite myelographic findings.

OPERATION (Jan. 21, 1948).—*Thoracic laminectomy* (J. T.) was performed under general anæsthesia. An incision was made over the spines of D.3–7 and a subperiosteal laminectomy of D.3–7 inclusive was carried out. As this was being done a dark pinkish, finely lobulated mass was seen lying in the extrathecal space, about

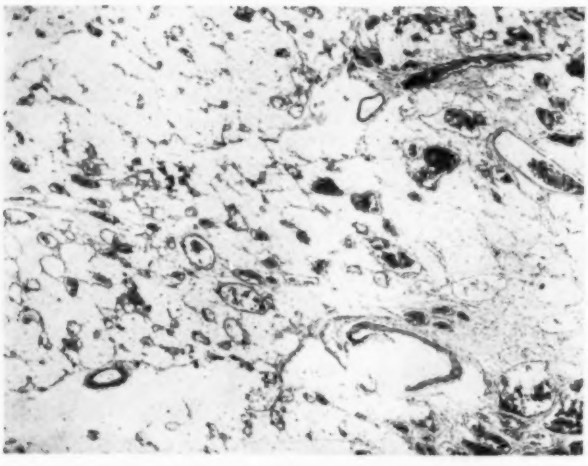

FIG. 2.—*Case* 1. Photomicrograph of tumour showing the meshwork of adipose tissue, thin-walled blood-spaces, and small vessels. A more cellular area is seen in the lower right-hand corner. (H. and E.) (× 12.)

2·5 × 1 cm., extending from D.3 to D.6 inclusive. The mass was entirely extrathecal and was removed without difficulty. There was little bleeding, and there were no large vessels entering the neoplasm. The dura mater was opened from D.3 to D.7. The meninges and cord were normal. The wound was closed.

POST-OPERATIVE COURSE.—This was uneventful. The retention of urine was treated by thrice daily catheterization. By the tenth day some voluntary power had returned to both legs, together with return of normal bladder function. The sensory level remained as before operation.

The patient made steady progress, so that by the fiftieth day she was walking with a stick. There were still infrequent nocturnal flexor spasms and abdominal cramps. The spasticity was less, the abdominal reflexes were absent, the knee and ankle reflexes remained exaggerated, and the plantar responses remained extensor.

The residual sensory changes were a band of hypalgesia at D.6–8 level, and loss of postural and vibration sense in the toes and feet. The patient was discharged on the seventieth post-operative day, still continuing to improve. Eight months after operation she was walking unaided, had a slight persistent spasticity of the right leg, no cutaneous sensory loss, but she still had bilateral extensor plantar responses.

HISTOLOGY (Professor G. R. Cameron).—The histological appearances showed the tumour to be a hæmangiolipoma (*Figs.* 2, 3).

Case 2.—G. L., female, aged 44 years. Housewife. Admitted to University College Hospital on the first occasion in April, 1946. (Referred later to us by Professor H. P. Himsworth.)

She was then complaining of: (1) Numbness and tingling in the left leg and to a lesser extent in the right leg for nine months. Walking had become difficult so that she stumbled and sometimes fell down. (2) Numbness of finger-tips and tingling in the right arm for two or three weeks before admission. (3) Incontinence of urine on straining (? stress incontinence) for sixteen years.

Past History.—Apparently irrelevant.

Personal History.—Appetite, bowels, and weight normal.

ON EXAMINATION.—A rather thin, pale woman. No demonstrable abnormality in the cardiovascular, respiratory, or alimentary systems.

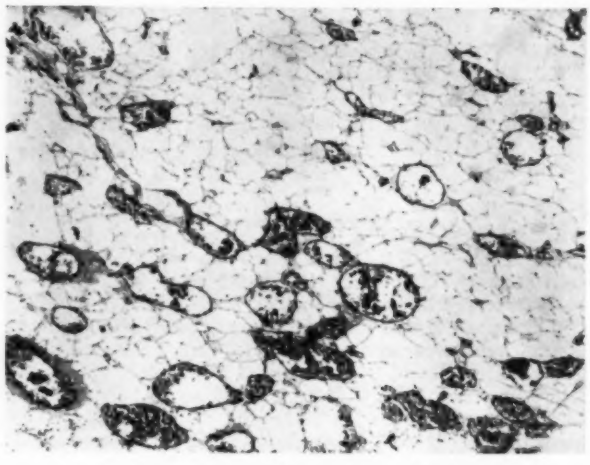

FIG. 3.—*Case* 1. Photomicrograph of tumour. Higher magnification. (H. and E.) (× 45.)

Central Nervous System.—Fundi and pupils normal. Eye movements normal. No nystagmus. Remaining cranial nerves also normal.

Upper limbs: No demonstrable sensory or motor abnormality.

Trunk: No demonstrable abnormality. Abdominal reflexes brisk.

Lower limbs: Motor—Some weakness of plantar flexion and dorsiflexion of both ankles. Moderate hypertonus in both limbs. Knee reflexes equally brisk. Ankle reflexes equally brisk with transient clonus. The plantar responses were both extensor. *Sensory*—There was loss of vibration sense below the iliac crests and position sense in the toes was diminished. There was a doubtful diminution of sensitivity to pain in both legs, but temperature sensation was unaltered.

Investigations.—

a. Radiological examination of spine: No abnormality demonstrated.

b. Blood-Wassermann reaction negative. Blood-count normal.

c. Fractional test-meal: Normal acid curve.

d. Lumbar cerebrospinal fluid: Pressure 128 mm. Clear, colourless fluid. Manometry normal. White cells 4 per ml. Red cells 5 per ml. Chemistry: Protein 90 mg./100 ml.; Pandy test negative; Chlorides 700 mg./100 ml.; Wassermann reaction negative.

The case was regarded as being one of disseminated sclerosis of late onset and the patient was discharged from hospital to attend as an out-patient for medical treatment and observation.

Her condition improved considerably and she returned to work for a time. In August, 1947, she fell whilst boarding a bus. Her legs became stiffer and weaker, so that walking was extremely difficult even with support, and she complained of pain in the small of her back.

She made no further reference to symptoms in her upper limbs. She was re-admitted to University College Hospital in March, 1948.

ON EXAMINATION.—There were no abnormal physical signs on examination of the cranial nerves, upper limbs, or trunk.

Central Nervous System.—

Lower limbs: Motor—Marked hypertonus right and left with adductor spasm. Gross weakness of the toe, ankle, and knee movements, and of extension and flexion of the hips. She could still abduct and adduct at both hips. *Reflexes*—All reflexes exaggerated right and left. No clonus. Both plantar responses were extensor. *Sensory* (*Fig.* 4)—Impairment of all modalities below the groins, i.e., below L.2 segment. No sacral sparing was noted.

Sphincters: Continent of urine except on straining. Continent of fæces.

Gait: She was unable to stand or walk unaided.

Investigations.—

a. Radiological examination of thoracic and lumbar spine: "The pedicles of D.11, D.12, and L.1 are eroded on the right side with widening of the interpeduncular intervals." (*Fig.* 5.)

b. Lumbar puncture: Manometry showed a partial block on jugular compression. Protein 80 mg./100 ml. Other readings as before.

c. Cisternal myelography: Persistent partial arrest of the medium after elevation of the patient to the erect position for half an hour, at the level of D.10–11. (Myodil 1·5 ml.)

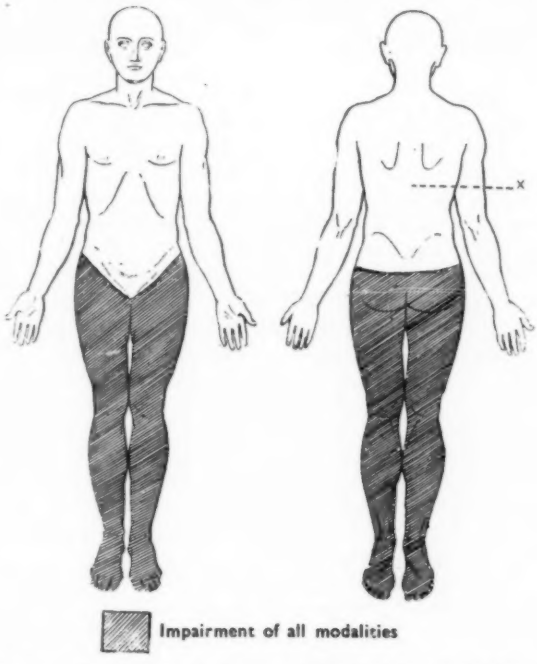

FIG. 4.—Sensory loss in *Case* 2. X, Myelogram shows partial block (D.11).

A diagnosis was made of spinal neoplasm, probably extrathecal, at the level of D.11, and exploratory laminectomy decided upon.

OPERATION (March 23, 1948).—*Thoracic laminectomy* (J. T.) was performed under general anæsthesia. The spines and laminæ of D.11, D.12, and L.1 were removed to expose a reddish extrathecal mass approximately 6 × 1 × 1 cm. lying on the dorsal surface of the theca, apparently continuous with the extrathecal fat, but firmer in consistence. It was not attached to the theca, was readily separated from the latter by blunt dissection, and removed with negligible bleeding. The theca was opened, but the cord and its vessels appeared to be normal. The wound was closed.

POST-OPERATIVE COURSE.—The patient made an uneventful recovery from the operation, and slowly but progressively regained the use of her lower limbs, with a corresponding regression of the sensory disturbance.

She was discharged from hospital on May 4 with good power in all segments of her lower limbs, but with slight residual spasticity. Her plantar responses were both flexor. There was no discernible sensory loss, and her bladder control was apparently normal. She has remained well since (May, 1949).

FIG. 5.—*Case* 2. Radiograph of the lower thoracic spine, showing erosion of the pedicles on the right side and widening of the interpeduncular distances of D.11, D.12, and L.1. The marker lies between D.11, D.12. Traces of myodil can be seen above and below the tumour.

HISTOLOGY (Professor G. R. Cameron).—The microscopical section of the tumour showed it to be a hæmangiolipoma (*Figs.* 6, 7).

COMMENT

1. Clinical Features.—Both patients were women. Both cases presented themselves finally as examples of paraplegia, which on clinical grounds seemed probably to be due to extramedullary lesions. They had well-defined sensory levels, but no sacral sparing. There was disturbance of bladder function, though in *Case* 2 this may have been due to a minor degree of uterine prolapse.

The clinical evidence was given some support by the myelographic findings, which, although indicating only a partial block, were of considerable localizing value. In each case 80 mg./100 ml. of protein was found in the cerebrospinal fluid—again suggestive of an extramedullary or, more probably, an extrathecal lesion.

Each case showed a fluctuating course. In *Case* 1 no less than nine years had elapsed since the onset of her symptoms, and during this time she had had complete remissions of symptoms on three occasions.

In *Case* 2, where symptoms were of some two years' duration, there was one remission lasting several months, during which time she was able to carry on her work as a housewife, which had previously been impossible.

In both cases also a provisional diagnosis of disseminated sclerosis had been made, despite some inconsistent findings, until their last admission to hospital. The clinical examinations, cerebrospinal fluid investigations, and radiological studies (including myelography in *Case* 1) had been made in the earlier stages of their illnesses without causing modification of the diagnoses.

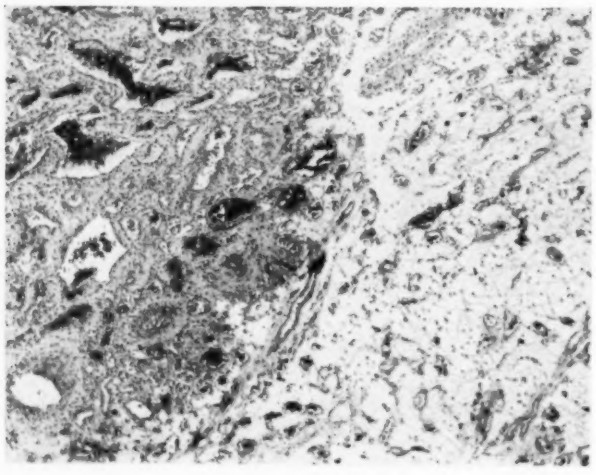

FIG. 6.—*Case* 2. Photomicrograph of tumour showing more truly angiomatous tissue on the left, with blood-spaces and surrounding fibrous tissue. Fat cells and blood-spaces are seen on the right. (H. and E.) (× 22·5.)

It is of interest that Stookey (1927) has commented on the fluctuation of physical signs shown by angiolipomas and other extradural tumours.

There were no cutaneous nævi or tumours noted in our cases.

2. Radiological Features.—Radiographs of the thoracic spine of *Case* 1 showed no abnormality in the anteroposterior or oblique projections. In the radiographs of *Case* 2, however, there is definite evidence of erosion of the pedicles on the right side and relative widening of the interpeduncular distance of D.11, D.12, and L.1 in the films taken on her second admission to hospital (*Fig.* 5). When re-examined, the films taken on her first admission two years previously showed a very slight degree of erosion which had not been commented upon at that time. The corresponding intervertebral foramina are not seen to be enlarged in the oblique projections.

According to Dyke (1942) few spinal neoplasms cause erosion of several adjacent pedicles. He mentions lipomas, congenital cysts, ependymomas, and the giant tumours of the cauda equina, as being likely to produce destructive changes in a number of vertebræ.

In the radiographs of our cases no distortion of the paraspinal tissues was seen. There is no evidence of spina bifida or other congenital deformities in either case. Cisternal myelography was carried out on both cases and we have no additional comment to make on the findings reported in the case-histories above, other than to note that only a partial block was found in both, and that only a few globules remained arrested above the tumour in each.

3. Histology.—Both tumours are similar on microscopical examination (hæmatoxylin and eosin preparations).

In general there is a meshwork of adipose tissue containing, scattered among it, numerous thin-walled blood-spaces with a single layer of flattened endothelial cells delimiting them from the surrounding fat cells. Here and there in addition small arteries with well-formed adventitia, muscular layers, and internal elastic laminæ are seen. There are also vessels of a similar but less robust nature which are probably venules. In the sections examined there was no evidence of thrombosis, and no hæmosiderin or evidence of previous hæmorrhage could be made out.

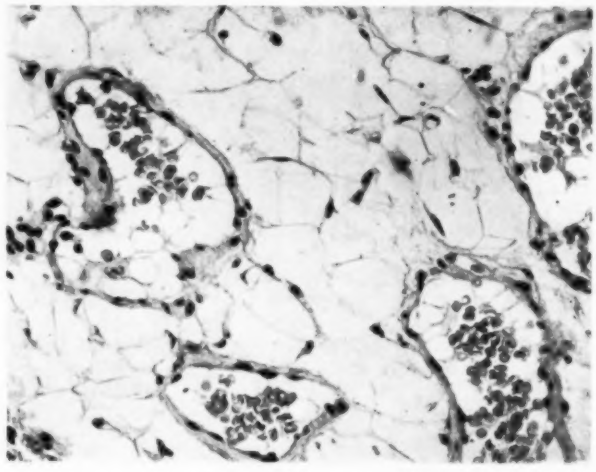

FIG. 7.—*Case* 2. Photomicrograph of tumour. Higher magnification. (H. and E.) (× 270.)

The tumour from *Case* 1 shows little variation from the above description, but in that from *Case* 2, in addition to large areas exactly conforming to the foregoing account, there are areas of more truly angiomatous tissue containing thin-walled blood-spaces lined by endothelial cells and interspersed with cellular fibrous tissue.

In the tumour from *Case* 1 there are similar but much smaller areas where the blood-spaces are aggregated in little clumps with a surrounding cellular fibrous tissue. In these areas there are to be seen small clumps of fat cells isolated from the main fat-cell-containing regions, but possibly prolongations from them.

Comparison of these tumours with the not uncommon angiolipomas found in soft tissues elsewhere in the body reveals no essential difference of structure.

We do not consider that the fat cells are included areas of extrathecal fat within an angioma for the following reasons :—

1. At operation the tumours were distinct from the extrathecal fat, and very little dissection was required to lift them from their surroundings, to which they were only lightly adherent.

2. In *Case* 1 the bulk of the tumour is almost wholly composed of fat, the blood-vessels merely forming a framework for it.

3. In the angiomatous areas noted in *Case* 2 fat cells are to be found in small clumps, lying quite isolated from the surrounding main fatty part of the tumour.

The implications of these remarks will be apparent from the following brief review of the literature.

LITERATURE CONCERNING SPINAL ANGIOMAS AND LIPOMAS

Numerous writers have shown that extrathecal lipomas are common in association with spina bifida and the accompanying malformations of the meninges and spinal cord (Chiari and von Recklinghausen, quoted by Stookey, 1927; Schlesinger, 1898; Wolf, 1942, a; Bucy and Gustavson, 1938), and in most series this variety of tumour has been specifically excluded (Stookey, 1927; Baker and Adams, 1938). Stookey (1927) also makes it clear that lipomas in general are frequently associated with congenital abnormalities elsewhere in the body.

Lipomas of the spinal cord are to be found as intramedullary, extramedullary, and extrathecal tumours. According to Wolf (1942, a), they occur "not infrequently" as spinal extradural neoplasms, but only rarely intradurally, although of Elsberg's (1942) 4 reported cases, 3 were intradural and 1 associated with spina bifida.

Stookey (1927) has presented a comprehensive review of the spinal lipomas reported up to 1926. A later review by Ehni and Love (1945) showed that lipomas constituted 1 per cent of intraspinal tumours. They found 29 cases of intradural and 20 cases of extradural lipoma in the literature (including those reported by them), and of these 7 were angiomatous. Bucy and Ritchey (1947) described another patient with a hæmangiolipoma causing cord compression and associated with the congenital deformity of the spinal column known as Klippel-Feil's syndrome. *Table I*, part of which is abstracted from the paper by Ehni and Love, includes the cases reported since.* Berenbruch's case (1890) showed all gradations from pure lipoma to pure angioma. Ehni and Love's first case showed a period of remission of nineteen months comparable with those we have described.

Pure angiomas are described by Wolf (1942, b) as of infrequent occurrence in the spinal cord and meninges. He cites 5 examples of this type among 253 intraspinal neoplasms, of which "2 were extradural, 1 was leptomeningeal and intramedullary, 1 extradural and vertebral, and 1 purely vertebral". The two extradural angiomas he describes (and illustrates one), show thin-walled vessels "intimately dispersed with the epidural fat" and are not dissimilar from the appearance of our *Case* 1. He does not refer to the gross appearance, however, and gives no clue as to the ease or difficulty of separation from the surrounding extrathecal fat at operation. It might be that these tumours are indeed other examples of those which we are describing as hæmangiolipomas.

Cushing and Bailey (1928) were able to find 17 cases of spinal cord angioma reported in the

Table I.—Reported Cases of Extrathecal Hæmangiolipomas of the Spinal Canal

Case	Year	Author	Sex	Age at Onset of Symptoms	Duration	Level	Spinal Puncture	X-ray Changes	Other Disorders	Outcome
1	1890	Berenbruch, K.	M.	16	2½ months	Dorsal	—	—	Lipomas of back; angiolipoma of renal capsule; angioma of cord	Operation; necropsy
2	1901	Liebscher, C.	F.	51	4½ years	D.7–D.8	—	—	—	Necropsy
3	1918	Frazier, G. H., and Allen, A. R.	F.	55	—	—	—	—	—	—
4	1929	Kasper, J. A., and Cowan, A.	M.	6	—	C.2–D.8, L.3–sacrum (2 tumours)	No block; globulin present	—	—	Necropsy; death from lumbar puncture
5	1931	Petit-Dutaillis and Christophe	F.	43	1 year	D.6–D.10	Complete block; 800 mg. of protein per 100 ml.	Bone normal; partial block in myelogram	—	Operation; recovery
6	1945	Ehni, G., and Love, J. G.	F.	30	3 years with 1 remission	D.6–D.8	Partial block; 30 mg. of protein per 100 ml.	Normal	Obesity	Operation; recovery
7	1945	Ehni, G., and Love, J. G.	M.	67	1 year	D.8–D.9	Partial block; 75 mg. of protein per 100 ml.	Normal	—	Operation; recovery
8	1947	Bucy, P. C., and Ritchey, H.	M.	33	10 weeks episode at 14 years	C.6–D.5	Partial block; 200 mg. of protein per 100 ml.	Fusion of cervical vertebræ; erosion of pedicles D.1–D.5	Klippel-Feil's syndrome	Operation; recovery
9	1949	*Case* 1 in this paper	F.	51	9 years with 3 remissions	D.3–D.7	No block; 80 mg. of protein per 100 ml.	Partial block in myelogram; normal spine	Obesity	Operation; recovery
10	1949	*Case* 2 in this paper	F.	44	2 years with 1 remission	D.11–L.1	Partial block; 80 mg. of protein per 100 ml.	Erosion of pedicles of D.11–L.1 on R., with widened interpeduncular distances	—	Operation; recovery

* Up to December, 1949.

literature (excluding a case recorded by Cobb, 1915), all apparently intradural.

In 1929 Globus and Doshay, in a review of spinal vascular anomalies, collected 10 examples of extradural hæmangiomas from the literature and stated that they form the largest group of hæmangiomas of the spinal cord or its coverings. Mixter (1932), and Connell and Hay (1930) recorded, in all, 3 further similar examples.

Since that time others have been reported, and Kaplan (1935) and Johnson (1938) each recorded a case of extradural hæmangioma with paraplegia, associated with a cutaneous nævus in the same metamere.

In an interesting article Turner and Kernohan (1941) made a pathological study of 46 cases of vascular malformations and vascular neoplasms of the spinal cord. Vascular neoplasms they believed to be true tumours, but stated that many gradations from the very simple to the very complex may be found. Vascular malformations they regarded as " angiomatous developmental anomalies capable . . . of further alteration in size and character ", and subdivided them into telangiectases and developmental defects (hamartomas, *see below*), which " at times take on the characteristics of blastomatous lesions ". Among the latter they included angiomas composed of " large tortuous and often abnormally formed vessels ". Such lesions may be purely venous in character or a complex mass of arteriovenous channels.

They recorded 28 vascular neoplasms, of which 15 were extradural in situation, 10 subdural, and 3 intramedullary. They further subdivided their group of neoplasms into capillary hæmangiomas, capillary hæmangio-endotheliomas, cavernous hæmangiomas, hæmangioblastomas, and hæmangiosarcomas. Two only of these tumours were capillary hæmangiomas, both were extradural, and both lay in the midthoracic region. Microscopically they were composed of capillary elements of flattened endothelium, the vascular channels thus formed being rather larger than capillary size, with scattered regions of cellular tissue between the channels. In both growths a moderate amount of lipomatous tissue was present in the form of large fat cells. They stated the belief that the fat cells were inclusions from the surrounding extradural fatty tissue. The histological appearances of these tumours are therefore not unlike those of the two cases we have described. Ehni and Love (1945) consider that extradural lipomas arise from bipotential mesenchyme cells about the adult capillaries which can develop into either blood-vessels or fat.

The origin of angiomas has been considered and discussed by several authors. Virchow (1863) believed them to be neoplasms, and this view was supported by Ribbert (1898). Later Enders (1908) thought them to be neoplastic malformations, whilst Borst (1913) regarded them as simple anomalies. Wolf (1942, b) stated that " angiomas are at present considered by most pathologists to be developmental vascular anomalies capable of subsequent alteration in size and character ".

Cushing and Bailey (1928) revived Albrecht's term hamartoma (Albrecht, 1904) in describing angiomatous malformations, and proceeded to discuss the organization of the primordial vascular plexus into the adult system in relation to the central nervous system. In their opinion hæmangioblastomas, which they regarded as true tumours, arise from changes occurring at an early stage in the development of the vascular network, whilst the angiomas—associated with cutaneous nævi on the scalp, varices in the dura, and venous angiomas of the pia—are developmental anomalies arising at a later stage in differentiation. Cushing and Bailey further implied that some tumours termed angiolipomas may be better known as hæmangioblastomas.

Willis (1948, a), however, whilst agreeing that from a clinical standpoint hæmangioblastomas have been usefully regarded as tumours, denies that pathologically they are so, and states that " with rare and doubtful exceptions all angiomas of the nervous system are developmental vascular hamartomas ".

Willis (1948, b) extends his conception of a hamartoma to cover other anomalies of development of mesenchymal tissue, and discusses congenital anomalies of adipose tissue in this light, calling them adipose hamartomas. " Doubtless," he says, " some of these congenital lipomas are not true tumours, but hamartomas—superfluous tumour-like masses of improperly blended tissues, comparable with most ' angiomas ' and without powers of disproportionate progressive growth."

CONCLUSION

We have little hesitation in distinguishing the tumours we have described as hæmangiolipomas, for, as we have indicated above, they formed discrete lesions readily separable at operation from their surroundings and consisting of angiomatous tissue dispersed freely amongst the fat cells that composed the bulk of the tumours. There was no histological evidence that the tumours contained any hæmangioblastomatous tissue.

It is difficult to account for the fluctuation of symptoms that occurred in both patients. Sections of the tumours showed no evidence of the occurrence of hæmorrhage or thrombosis, either of recent or earlier date, and we are left with the hypothetical consideration that the waxing and waning of the symptoms and physical signs may have been due to changes in volume of the tumours, the causes of which remain a matter for speculation. A similar variation in the intensity of symptoms and signs is characteristic of intrathecal hæmangiomas.

With regard to the ultimate nature of such ' tumours '—whether they are congenital developmental anomalies (i.e., hamartomas) or true neoplasms—we have neither evidence nor argument to offer.

SUMMARY

1. Two cases of hæmangiolipoma of the extrathecal tissues of the thoracic spinal canal are described.

2. Comment on the clinical, radiological, and histological features is given.

3. The literature is reviewed and the present concept of such lesions is discussed.

Acknowledgements.—We wish to thank Dr. K. E. Harris and Professor H. P. Himsworth, in whose care the patients respectively were admitted to University College Hospital, for their kind permission to publish this account of their cases.

We would also like to express great appreciation to Professor G. R. Cameron for his reports on the tumours removed, and for advice on their histology.

To Mr. J. Bayley, Senior Technician of the Department of Morbid Anatomy, and Mr. K. S. Macdonald, of the Photographic Department, University College Hospital Medical School, our thanks are also due for the preparation of the histological sections and photomicrographs respectively.

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PITUITARY TUMOURS

OBSERVATIONS ON LARGE TUMOURS WHICH HAVE SPREAD WIDELY BEYOND THE CONFINES OF THE SELLA TURCICA

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PROBABLY most surgeons who have had to deal with tumours of the pituitary gland would agree that the removal of a growth of modest proportions, undertaken before irreparable damage has been done to the visual pathways and other nearby structures, is a reasonably safe, artistic, and gratifying procedure; and few would disagree with the view that the removal of large tumours which have spread widely beyond the confines of the sella turcica is highly dangerous, and, far from being artistic and gratifying, usually ends in disaster. Not unnaturally text-books of surgery give much attention to the former group, but not to the latter.

It may be that larger growths of the type to be described in this paper will for ever thwart the best efforts of surgeons to effect a satisfactory removal. It is well, however, to remember that in the long story of surgery, apparently insurmountable difficulties have time and again been overcome and not to despair.

For years past the author has taken every opportunity which has presented itself to study the habits of tumours occurring in the pituitary gland, with the idea in mind that with increasing knowledge he might be better equipped to plan and execute the proper surgical treatment. In this paper are set down some of the results of these investigations.

METHODS AND MATERIAL

The majority of the observations have been taken from post-mortem specimens. Even in these it has often been difficult to make out the relationships of the various structures in the region in question. Faulty methods were employed in removing and examining many of the earlier specimens, and in consequence the results were disappointing. It became clear that in order to be able to study pituitary tumours at leisure, it was necessary to remove the whole brain in the dura mater, together with a great part of the base of the skull. After removing the vault of the skull in the usual way, the dura mater was carefully stripped from the bone until the base of the skull was reached. It was *not* stripped from the base in the anterior and middle fossæ, nor from the anterior part of the cerebellar fossa. The stripping was continued posteriorly to and beyond the foramen magnum. A broad chisel was then used to cut through the bone of the base along a line passing roughly from the crista galli across the orbital roof to the outer part of the

sphenoid ridge, thence backwards to cross the petrous bone well outside its midpoint, and so to the foramen magnum behind the condyles. With the aid of strong scissors, soft tissues were divided and at length the specimen was removed and placed in 10 per cent formol saline which was renewed several times at intervals of every few days. It was found that fixation of the midbrain region was sometimes defective, and latterly formalin solution has been injected into the lateral ventricles and into the carotid arteries.

The region occupied by the tumour and the midbrain was exposed from each side by removing a large amount of brain, as shown in *Fig.* 14. Later the specimen was cut in two by a midline sagittal section, to permit of inspection of the tumour from the medial aspect. Finally the tumour was removed from its bed in each half of the specimen as well as it could be without disturbing related structures.

Photographs were taken at different stages of the dissection, but these were often disappointing, and it was necessary to make sketches and diagrams. Here the author was much handicapped, being a very poor draughtsman and not having the services of an artist at his command. Finally the sketches were re-drawn by an artist.

CASE NOTES

No detailed case reports are included in this paper. The clinical features are discussed only in a general way. Points of interest from individual histories are mentioned in appropriate places in the text. Of 13 patients from whom specimens were obtained after death, 8 cases (*Cases* 1, 5, 6, 7, 8, 9, 10, 13) had been subjected to operation and died whilst still in hospital; 2 cases (*Cases* 4, 11) survived a first operation for some years only to die after a second attempt at removal; 2 cases (*Cases* 2, 3) died some years after a single operation; and 1 case (*Case* 12) survived two operations but died some years later. Possibly the surgical interference had some effect upon the way of growth and final appearance of the tumours.

THE PITUITARY GLAND

The bulk of the pituitary gland is not such as to give any hint of its importance in the human economy. Compared with the thyroid gland, the liver, the adrenal glands, and the pancreas, it makes but a poor show. Nevertheless this puny gland exerts, through its secretions, a controlling influence such that it has been called the 'master of the endocrine system'; and it is so situated in relation to the brain, important cranial nerves, and blood-vessels, that when its bulk is greatly increased by abnormal growth, it causes much embarrassment to these structures and menaces life itself.

With disorders of glandular secretions this paper is not concerned. It is proposed to discuss the way in which tumours of the hypophysis expand, and the effects produced upon the various structures in the neighbourhood.

The pituitary gland weighs about half a gramme, its average dimensions being 13 × 10 × 6 mm. It is snugly housed in the sella turcica and surrounded by a layer of the dura mater, excepting above, where there is an opening in the roof, or diaphragm, through which the pituitary stalk passes.

An adenoma of the hypophysis may come to surpass in bulk a hundred times its parent gland. In doing so it spreads far beyond the confines of the sella turcica, and meets in its passage many structures. Some of these offer high resistance to the slowly moving growth, and yield but little ground, so that the advance is held up, locally at least, for a long time. Thus the dura mater over the dorsum sellæ and the basisphenoid serves to hinder direct backward extension, and the strong ligamentous attachments of the tentorium to the clinoids stand firm. Large arteries, particularly the carotids, preserve their living space, and continue to function, although they may be stretched and displaced somewhat. The tumour, to advance, must perforce pass by on one side, or both sides, of the vessels, which may come in this way to lie deeply embedded in its substance.

Tissues of a less stubborn character offer but little hindrance to the invader. Bone in the dorsum and floor of the sella turcica yields place first by bulging and then by disappearing. Later the lateral walls of the sphenoidal sinus are similarly destroyed, and finally the growth may break through the last bony barrier, the floor of the sphenoidal sinus, to bulge into the nasopharynx (*Fig.* 10). Various defenceless cranial nerves are displaced, stretched, flattened, and kinked unmercifully, but slowly, so that often they continue to function bravely for a long time when it seems impossible that they should do so. The brain substance itself offers little resistance to the march of the tumour, but here again function is not always lost early. The pituitary gland, which gave birth to such a terrible offspring, is contemptuously thrust aside and flattened wellnigh out of recognition.

The Way of Growth of an Adenoma of the Pituitary Gland.—Adenomas arise in the anterior lobe of the pituitary gland very frequently. Costello (1936) claimed to have demonstrated them in 22 per cent of 1000 unselected glands which he examined. Tiny tumours such as these give rise to no detectable signs or symptoms, if basophilic tumours are excluded. Presumably most of them never attain to a size sufficient to cause trouble. Some, however, continue to grow and enlarge until they bring about their own death by destroying their host.

Imagine a tiny adenoma in the anterior lobe of a pituitary gland. It is of no importance as yet and gives no hint of its presence, but slowly it increases in size. It is more or less spherical in shape, and as it grows it tends to keep this form, expanding in all directions outwards from its centre. Later on it will meet here and there with resistance which will hinder this uniform centrifugal extension. Held up at one place, the growth will push on at other points where the going is easier. It may break through a barrier at some point and push on in a field of less resistance as a pedunculated bud, which in time may rival, or even surpass, in bulk, the older part of the tumour. 'Budding' is quite a pronounced feature of some growths. The buds are covered by a thin capsule which is continuous with that of the parent adenoma.

It will now be convenient to consider in more detail the effects of an expanding tumour upon the

neighbouring structures. The growth tends to expand downwards and forwards, depressing the floor of the pituitary fossa into the sphenoidal sinus and basisphenoid; laterally towards the cavernous sinuses; and upwards into the cranial cavity.

Downward Spread.—Looked at from above, the bony floor of the sella turcica is deeply concave in the sagittal plane, and flat or very slightly concave from side to side. For the most part it is composed of a thin layer of compact bone. When the sphenoidal air sinuses are well developed they extend to the base of the dorsum sellæ and into the body of the sphenoid, and there is but little cancellous bone in this region (*Fig.* 8). When the sinus does not extend so far, the posterior part of the floor of the pituitary fossa rests on the cancellous bone of the body of the sphenoid. In either case the bony floor seems to offer but slight resistance to the pressure of the growth. First it bulges forwards and downwards, becoming more deeply concave in both the sagittal and coronal planes (*Fig.* 9). In the dorsum sellæ the bone tends to disappear rather than to bulge. It is clear that during this phase, bone must

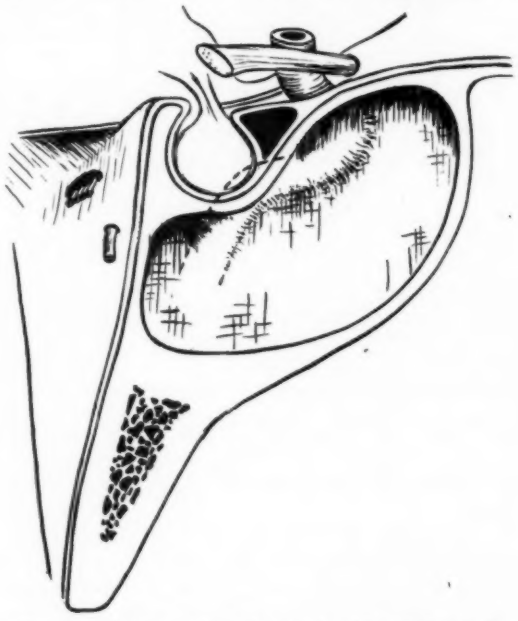

FIG. 8.—Sketch to show the relationship of the pituitary gland to adjacent structures, as seen in a midsagittal section. The sphenoid sinus is well developed and extends to the base of the dorsum sellæ. The carotid artery, as it passes across its lateral wall, causes it to bulge slightly into the sinus. From this sketch it may be seen how a tumour spreading laterally from the sella turcica will pass below the attachment of the tentorium to the anterior clinoid process and above the carotid artery.

have been removed progressively and simultaneously deposited to conform to the new contour of the sellar contents. The dural covering of the floor of the fossa stretches at the same time. The mucoperiosteum of the sphenoidal sinuses moves in conformity with the bony floor of the fossa and the septum adjusts itself. When cancellous bone is well developed in the posterior part of the floor, the tumour makes good headway in this region. A radiograph taken at this stage shows ballooning of the sella with an intact bony floor. As the growth enlarges, removal of bone continues but deposition fails, until eventually all bone in the floor and dorsum sellæ disappears, and the tumour expands into the sphenoidal sinus, which it eventually fills. The mucoperiosteum of the sinus is reflected directly from the lateral walls on to the surface of the tumour, the sinus itself being reduced to a mere cleft. A radiograph taken at this stage shows no bone in the

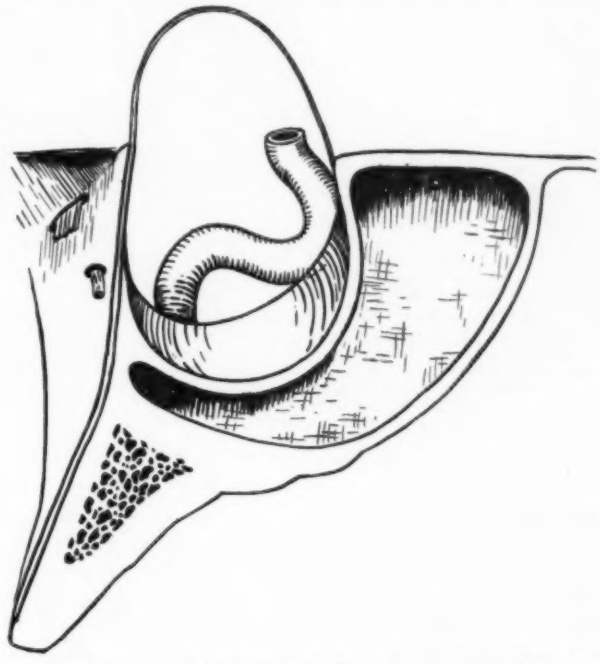

FIG. 9.—Sketch to show a pituitary adenoma of moderate dimensions (*Case* 1). The tumour has brought about a depression of the bony floor of the sella turcica but it is still intact. Note that the lower pole of the tumour now reaches below the level of the horizontal part of the carotid artery, so that lateral extension could now take place below the vessel as well as above it. The small midline intracranial extension pressed on the chiasma and left optic nerve. Compare *Fig.* 16.

dorsum sellæ and floor of the pituitary fossa, and no air, or very little, in the sinus.

If the patient lives long enough, the tumour tends to press upon and destroy the bony floor of the sinus, and comes thus to bulge into the nasopharynx. It might, presumably, press upwards through the roof of the sinus (jugum sphenoidale) to enter the anterior fossa of the skull. Lateral spread of the tumour from the sphenoidal sinus will be dealt with in the next section.

Lateral Spread.—The lateral extremities of the pituitary gland abut upon the medial walls of the cavernous sinuses. The carotid artery in its passage through the sinus is closely related to the pituitary gland, as shown in *Fig.* 8. The partition between the pituitary fossa and the sinus is thin and it offers but little resistance to the march of pituitary adenomas. The membrane stretches and bulges laterally, forming a small pouch projecting into the sinus below the interclinoid ligament and the attachment of the tentorium, which stand firm; and above the carotid artery, which yields but slightly. The lumen of the sinus is gradually encroached upon, until eventually no blood flows through it. The tumour, having passed the bottle-neck between the carotid artery and the attachment of the tentorium, expands to fill

the sinus and presses upon the lateral wall and the various nerves contained in it. The layer of dura mater over the lateral wall of the sinus is thrust

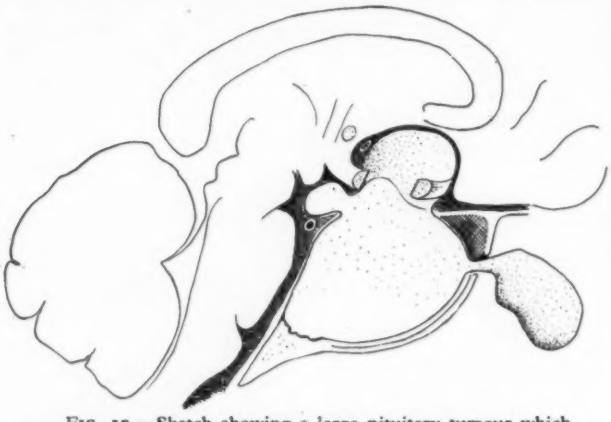

FIG. 10.—Sketch showing a large pituitary tumour which has developed chiefly below the diaphragm (*Case* 2). A large mass almost fills the sphenoid sinus and sends a pedunculated process through the left sphenoid ostium into the nasal cavity. A smaller suprasellar portion lies mainly to the left of the midline, pressing upwards into the region of the anterior perforated substance and displacing the left optic nerve, chiasma, and tract over to the right so that only a portion of the optic nerve and tract appear in the sketch. Compare *Figs.* 11, 12, 17 D.

laterally and caused to bulge into the medial surface of the temporal lobe (*see Figs.* 14, 24, 26 C).

The nerves in the lateral wall cannot escape. The third nerve pierces the roof of the sinus and gains the lateral wall well forwards and high up in

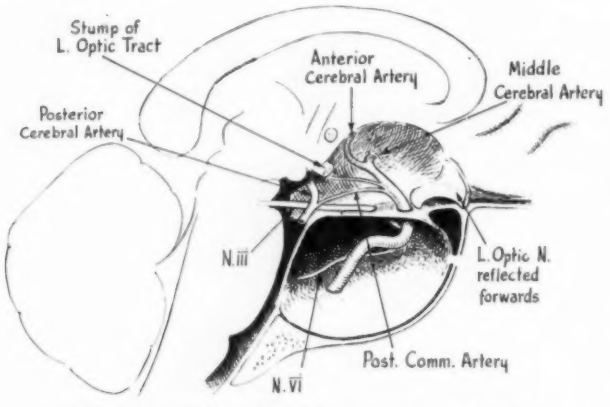

FIG. 11.—Sketch to show the bed, in the left half of the brain, of the tumour depicted in *Fig.* 10. The left optic nerve is shown reflected forwards. Note the relationships of the various vessels to the suprasellar nodule. There is no sign of a lateral wall to the sphenoid sinus, the tumour extending laterally beneath the dura mater of the middle fossa to the foramen ovale. The carotid artery and the sixth nerve are seen coursing through the cavity. They were completely embedded in the growth. The third nerve was compressed from above down by the suprasellar nodule and again in the roof of the cavity by the subdiaphragmatic mass.

relation to the tumour 'head'. It has but a short course in the sinus. The tumour thrusts it upwards against the roof and passes on. The fourth nerve has a similar but longer course at a lower level in the lateral wall, and is similarly, but more severely, displaced. Still lower down the ophthalmic division of the fifth nerve courses upwards and forwards in the lateral wall. The tumour presses it laterally and moves on beyond the confines of the sinus to gain the under aspect of the Gasserian ganglion, which thus comes to lie on the convex temporal surface of the subdural extension immediately beneath the dura mater. Progress now becomes more difficult. The dura mater is firmly anchored at the superior orbital fissure, the foramen rotundum, the foramen ovale, and along the superior angle of the petrous bone, and cannot be stripped up any further (*see Figs.* 14, 15).

The sixth nerve in its passage through the cavernous sinus crosses on the outer side of the vertical part of the carotid artery and is loosely attached to it. Thus it comes about that as the tumour spills over the horizontal part of the carotid artery and advances downwards along the vertical section which rises from the foramen lacerum, it

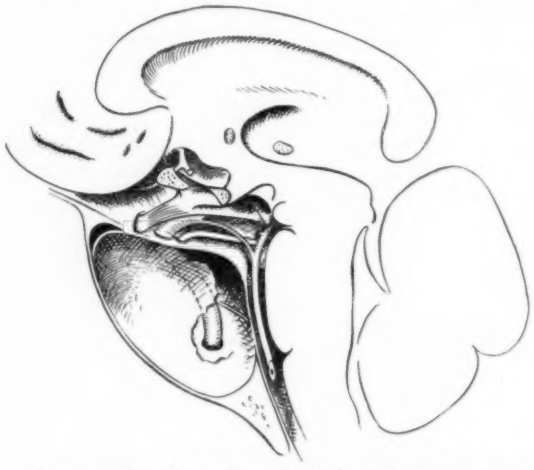

FIG. 12.—Sketch to show the bed of the tumour in the right half of the specimen, in *Case* 2, after removal of the growth. Note how the nerves of vision have been displaced so that the chiasma and part of the left optic nerve and tract lie to the right of the midline. The tumour has broken through into the cavernous sinus, but the lateral wall of the sphenoidal sinus, below the level of the carotid artery, is intact.

passes over the sixth nerve on its lateral aspect. The nerve comes thus to lie on the floor of the cavity which this extension of the tumour has made for itself.

In addition to expanding laterally above the carotid artery the tumour may send a process below the horizontal and in front of the vertical section of the artery, to enter the cavernous sinus. This can only take place after the floor of the sella turcica has been depressed well below the level of the arterial loop, as shown in *Fig.* 9. The two processes meet and completely surround the carotid artery.

Before considering the further spread of these lateral extensions, it is convenient to examine another movement.

The reader will remember that in the course of its downward growth the tumour eventually breaks through the floor of the sella turcica and comes to fill the sphenoidal sinus. Each lateral wall of the cavity in which it is now confined contains a thin layer of bone, except in the upper posterior quadrant. The bone of the lateral wall of the sinus in the region of the sellar floor participates in the adaptive moulding described in connexion with the downward extension, and thus when the floor of the sella turcica eventually disappears there is a largish defect in the lateral wall, high up and posteriorly. Laterally

the carotid artery crosses this opening (*Fig.* 9). For the most part the bony wall is, at this stage, still intact. When the tumour has grown sufficiently to fill the sinus, it begins to exert pressure laterally, as well as in other directions. The bony barrier here, as elsewhere, gives way, disappearing first at one or two points (*Fig.* 12) and eventually over its whole extent (*Fig.* 11). Another lateral extension, this time arising from the primary downward growth, moves on to reinforce the advance guard (*Fig.* 26 C). The extensions meet and seem to merge into one, although maybe their respective capsules remain to preserve some sort of division between them. The carotid artery and also the sixth nerve are surrounded and thus come to pass through the tumour.

The combined extensions continue to grow and struggle to escape from their prison. Above and laterally is the dura mater, reinforced by the Gasserian ganglion, its roots and branches. Below is the thick strong bone composing the base of the greater wing and root of the pterygoid process of the sphenoid bone. The resistance of the dura mater is more effective than that of the bony floor. The photograph (*Fig.* 15) shows the impress of a tumour on the bone of this region.

The growth, having entered the lumen of the cavernous sinus, might take the opportunity now offered of spreading along the various veins entering and leaving the sinus. Forward extensions would lead through the superior orbital fissure into the orbit. In *Fig.* 15 the greatly enlarged fissure on the left side indicates that such an extension had occurred. Spread along the superior petrosal sinus would carry the tumour backwards and laterally over the roots of the fifth nerve (*Fig.* 16), whilst extension along the inferior petrosal sinus would bring the tumour beneath the dura mater of the floor of the cerebellar fossa.

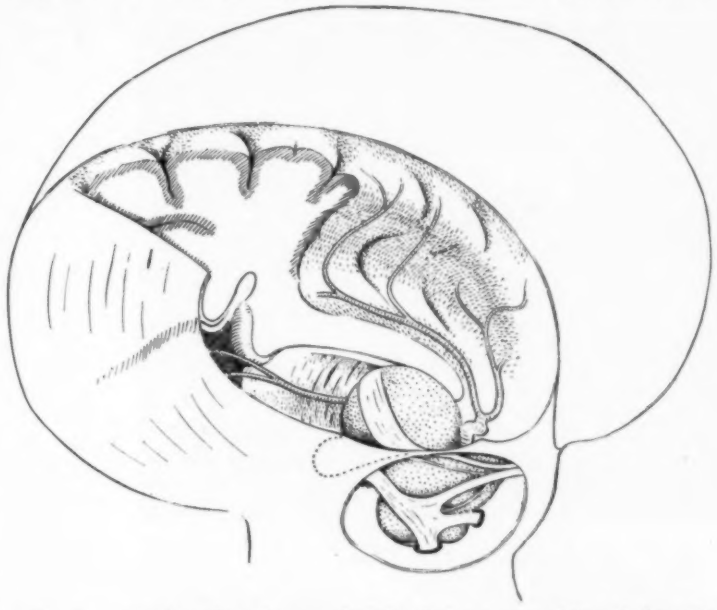

FIG. 14.—Sketch to show the extension of a pituitary tumour (*Case* 4) from the right side. A large part of the cerebrum has been removed to uncover the tentorium, part of the falx, the midbrain, and the intracranial extension of the adenoma. Note that the latter bulges into the midbrain and displaces it posteriorly so that it comes to lie in close contact with the free edge of the tentorium. The quadrigeminal plate is thrust against the splenium of the corpus callosum, which in turn is pressed against the free edge of the falx. Compare *Fig.* 22. The third nerve, greatly stretched and flattened, winds around the tumour on its outer aspect. A process, indicated by the interrupted line, passes laterally beneath the free edge of the tentorium, into the posterior fossa. The dura mater over the region of the cavernous sinus and Gasserian ganglion has been cut away to show the relationship of the tumour to the various nerves in the region. The tumour sends a blunt process into the superior orbital fissure.

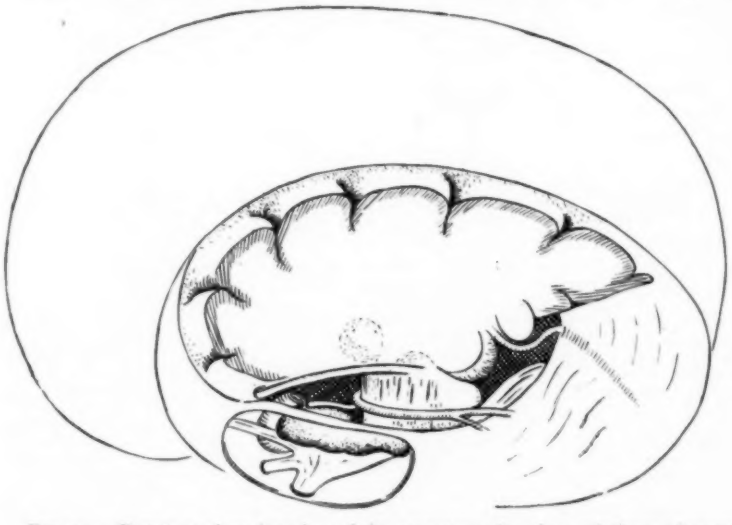

FIG. 13.—Sketch to show invasion of the cavernous sinus by a pituitary adenoma at an early stage (*Case* 3). The dura mater over the lateral aspect of the cavernous sinus and Gasserian ganglion has been cut away. The tumour lies chiefly above the horizontal limb of the carotid artery, and has not extended beneath the Gasserian ganglion. It reaches well back to the mouth of the superior petrosal sinus. A small nubbin of tumour has passed through the roof of the cavernous sinus to come to lie under the third nerve. There is no displacement of the midbrain. Note that there is a considerable space between the latter and the posterior extremity of the opening in the tent, through which the cerebellum may be seen. Compare *Fig.* 14.

Upward Growth.—The pituitary fossa is roofed in by a diaphragm in which is an opening for the stalk of the pituitary gland, which passes through it. The aperture varies in size, but is usually much greater in diameter than the stalk. It would seem to provide for an expanding pituitary growth an easy way of escape from the sella turcica, but sometimes, for no apparent reason, an adenoma will expand downwards and laterally, and even upwards by devious routes to be described later, whilst neglecting the seemingly most unguarded exit. Quite frequently, however, a pituitary tumour bulges into and through the aperture in the diaphragm, dilating it gradually so that its diameter may measure nearly 2 cm. across and thrusting the stalk of the pituitary gland to one side (*Fig.* 16). The interclinoid ligaments hold fast and limit the size of the opening, so that eventually the growth, as it escapes through and expands above the diaphragm, assumes an hour-glass shape.

The nodule which has now escaped from the sella turcica continues to grow.

It presses the infundibulum, like the pituitary gland, aside, and moves on to the next and more important victims, the optic nerves and chiasma. The way in which it will affect these structures depends to a large extent on whether the intracranial portions of the optic nerves are very short, of medium length, or longer than usual. In the first case the chiasma is said to be pre-fixed; in the last, post-fixed. When the optic nerves are unusually long the tumour rises in front of the chiasma, and gradually thrusts it upwards and backwards. More commonly the chiasma lies directly above the opening in the diaphragm of the sella and the growth as it rises impinges on its under-surface and pushes it upwards. Usually this relationship is not maintained, the tumour tending to pass eventually either in front of or behind the displaced chiasma. In a small percentage of cases in which the chiasma lies well

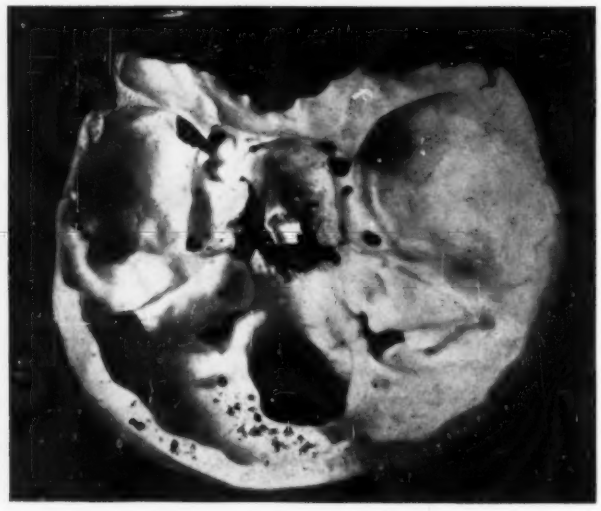

FIG. 15.—Photograph to show the effects of pressure of a large pituitary tumour on the base of the skull (*Case* 5). The floor of the sphenoidal sinus has largely disappeared. The tumour extended to the left as far as the foramen ovale and the foramen rotundum and made a deep impression in the bone between and medial to these openings. The tip of the left petrous bone and the basi-occiput show extensive erosion and the left superior orbital fissure is greatly enlarged as a result of destruction of its margins.

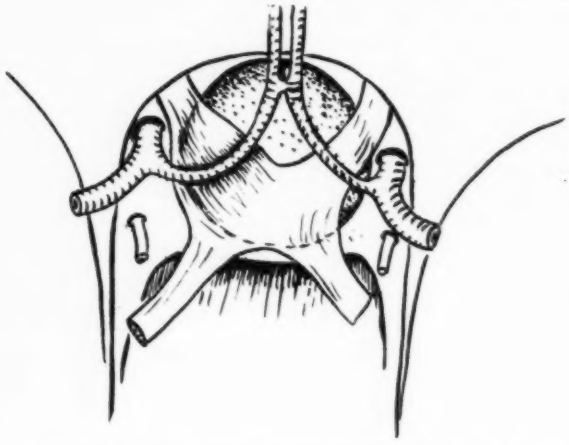

FIG. 16.—Sketch to show the relationships of the dome of the pituitary tumour in *Case* 1, as seen from above. An extension of moderate dimensions has passed through the aperture in the diaphragm, thrusting the stalk of the pituitary gland backwards and to the left, and bearing on the under aspect of the chiasma and left optic nerve. The latter structure was flattened by the tumour and pressed against the left anterior cerebral artery, which cut a deep groove across its superior surface. In consequence there was very little vision in the left eye, and only in part of the nasal field.

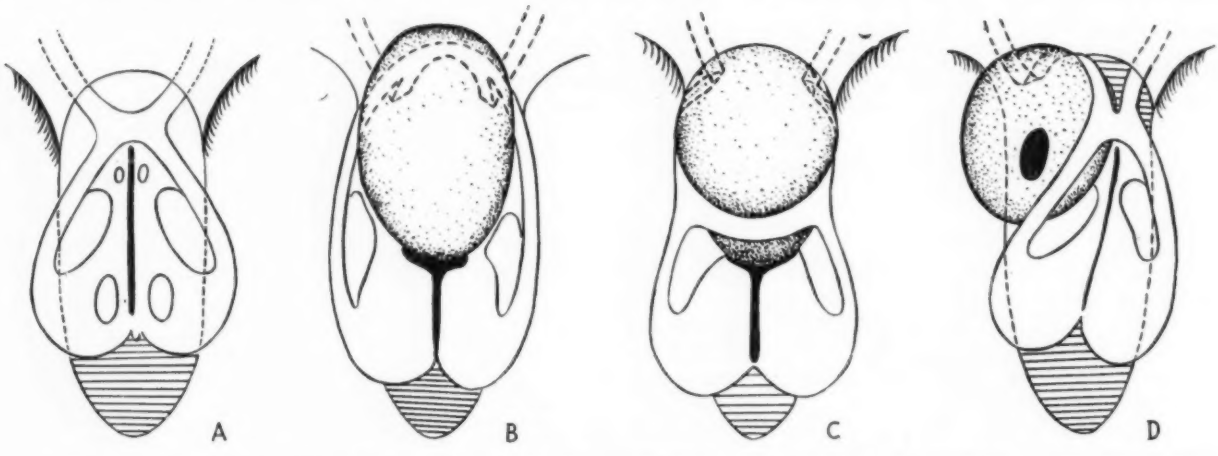

FIG. 17.—A, Diagram to illustrate the normal relationship of the midbrain and optic pathways to the opening in the tentorium. The section through the brain has been made obliquely in the plane of the optic tracts, and well above the plane of the opening in the tentorium. Here the midbrain is much wider than lower down; hence the apparent spread of the brain beyond the limits of the opening. Note that there is ample space between the posterior margin of the midbrain and the posterior extremity of the opening. Compare *Fig.* 21.

B, Diagram to illustrate the effects of a midline suprasellar extension of a pituitary tumour which has risen behind the chiasma. The latter is stretched and thrust forwards. The optic tracts are stretched and embrace the tumour. The latter inverts the floor of the third ventricle and bulges into the mesencephalon between the peduncles. It causes a widening and displacement backwards of the brain-stem, which may be nipped by the converging free margins of the tentorium.

C, Diagram to show the effects of a midline extension which has risen in front of the chiasma. The optic nerves are stretched and flattened, and embrace the tumour. The optic chiasma is thrust upwards and backwards into the third ventricle. The effect upon the brain-stem is much as in (B).

D, Diagram to show how an intracranial extension which has escaped from the roof of the cavernous sinus and risen to one side of the midline, affects the neighbouring structures. The left optic nerve is sharply kinked at the optic foramen, then passes round and over the tumour on its medial aspect. The tumour bears on the left peduncle from the outer side and passes the midbrain and third ventricle backwards and to the right.

forward, in close relationship to the tuberculum sellæ, the invader rises behind it, displacing it forwards but not much upwards. The optic nerves, chiasma, and tracts have no great tensile strength, but they may have some slight directive effect upon the course of the tumour. The optic nerves are fixed at the optic foramina, and any change in direction of the intracranial portions of the nerves brings about at this point an angulation which may be quite pronounced. The optic nerves, chiasma, and tracts may be greatly stretched and elongated, as well as displaced and flattened to tape-like proportions. *Fig.* 17 (B, C, D) shows diagrammatically some of the ways in which tumours may affect the visual tracts.

The nervous structures in question may continue to function reasonably well even when they are grossly distorted by the tumour, provided that the process is very slow and that no accomplice is called in to add further insult. When, however, a nerve, retreating before the growth, comes in contact with a more or less unyielding structure such as the anterior cerebral artery which crosses above the optic nerve near its junction with the chiasma, or the sharp bony margin of the optic foramen, its functional life is nearing its close. In *Fig.* 16 the sketch shows how a small intracranial extension bearing on the under-surface of the left optic nerve has pressed it against the left anterior cerebral artery, so that the nerve is almost severed. The sketch in *Fig.* 30 shows how acutely an optic nerve may be bent at its point of entry into the optic foramen.

The olfactory apparatus may be subjected to pressure at various points. Thus an adenoma growing forwards along the base of the anterior fossa of the skull, in the midline, thrusts the frontal lobes aside and presses upon the parolfactory areas

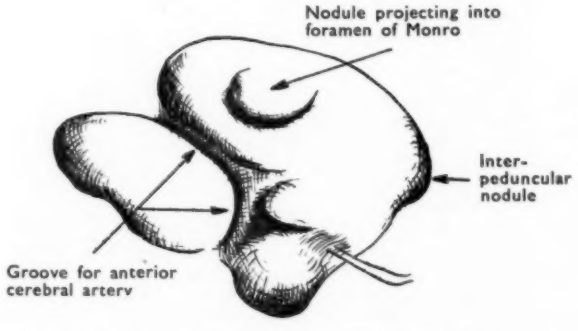

FIG. 18.—Sketch of a pituitary tumour which consisted of a large intracranial mass and a comparatively small sellar portion. The anterior cerebral and anterior communicating arteries made a deep groove on the lateral and anterior aspects of the growth. The chiasma probably lay behind the tumour, but this was not clearly made out. The growth bulged into the third ventricle and sent a nubbin into each foramen of Monro (*Case* 6). Compare *Fig.* 19.

of Broca. Soon it comes in direct contact with the olfactory tracts, much as does a meningioma arising in the region of the jugum sphenoidale. The tumour may pass over the olfactory tract, compressing it against the base of the anterior fossa, or it may thrust the tract laterally, so that it comes to lie in the wall of the cavity in the frontal lobe which houses the growth (*Fig.* 28). In the latter case function is less likely to be disturbed than in the former. Farther back a growth rising in the midline may press upon the mammillary bodies or even the columns of the fornix, whilst one spreading laterally may come in contact with the olfactory trigone and the anterior perforated substance. Still farther laterally the growth may bear upon, or burrow into,

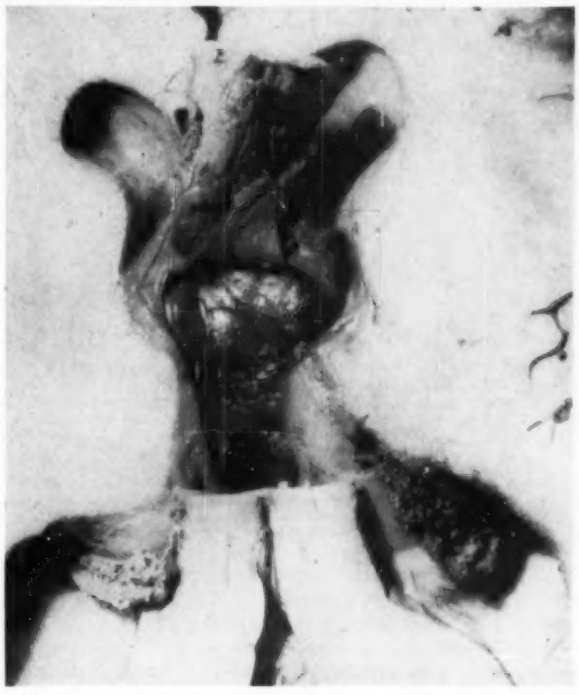

FIG. 19.—Photograph to show a pituitary adenoma in the third ventricle. The fornix has been reflected forwards. The tumour sends a blunt process into each foramen of Monro (*Case* 6).

the temporal lobe in the region of the uncus and hippocampus.

The arteries composing the circle of Willis are usually placed so that a tumour arising from the aperture in the diaphragm of the sella turcica and growing upwards in the midline must penetrate the circle. Whilst it is still of small size the growth does not make contact with any of the vessels, but as it grows it may reach any or all of them. The supraclinoid portions of the carotid vessels resist displacement and in order to advance, the tumour must perforce pass by on one side or other, most commonly on the posterior aspect. In time an artery may be completely surrounded. The anterior cerebral arteries and the anterior communicating artery form an archway crossing the midline a short distance above the tuberculum sellæ and in front of the optic chiasma. This archway becomes stretched across the anterior aspect of the tumour, which continues to grow upwards chiefly behind the vessels, but may also send a process forwards beneath the archway to extend along the floor of the anterior fossa of the skull between the frontal lobes (*Fig.* 18). Rarely an adenoma may pass forwards under the arterial arch, thrusting it upwards and backwards in much the same way as does a meningioma of the olfactory groove, as depicted by Cushing and Eisenhardt (1938) (*Figs.* 28–30). The posterior communicating vessels may be displaced laterally, and the posterior

cerebral and basilar arteries backwards, when the tumour attains sufficient size. The relationship of some of these vessels to extensions which do not keep to the midline will be discussed later.

It has already been mentioned that tumours arising in the pituitary gland compress the gland and

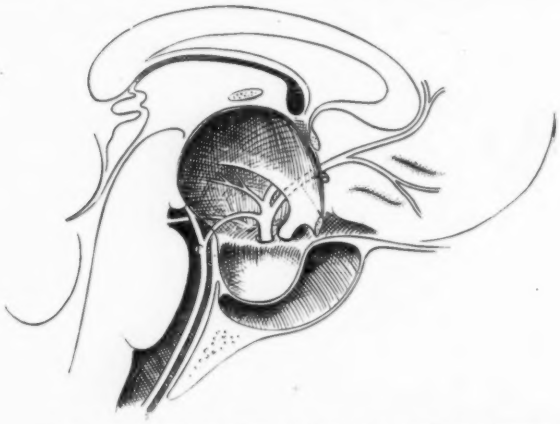

FIG. 20.—Sketch to show the bed of a pituitary adenoma in the left half of the specimen from *Case* 7. The tumour consisted of a sellar nodule of moderate dimensions, and a much larger intracranial extension which escaped through the aperture in the diaphragm and rose behind the chiasma to project into the third ventricle, the thinned out and inverted floor of which capped the tumour. Compare *Fig.* 17 B.

thrust it aside so that it may be difficult to find. As the growth emerges through the aperture in the diaphragm, the infundibulum is likewise displaced to the periphery of the opening, and probably, in most cases, away from the midline. Because of this the dome of the tumour comes as a rule to bear upon the tuber cinereum to one side or other of its centre, and thrusts it towards the other side. Suppose now that the tumour continues to grow upwards behind the optic chiasma. As it enlarges it presses upon that part of the hypothalamus lying below the optic tracts, and gradually stretches it so that in time it is represented only by a paper-like sheet of tissue paper capping the dome of the growth (*Fig.* 20). The chiasma is displaced forwards, whilst the mammillary bodies are carried backwards and compressed against the cerebral peduncles, which are also displaced, indented, and thrust apart. The optic tracts are bowed laterally and compressed against the medial surfaces of the temporal lobes. The growth, capped by the attenuated and inverted floor of the third ventricle, eventually fills the anterior part of the ventricle and may reach to the foramina of Monro and send processes into the lateral ventricles (*Figs.* 18, 19). The tumour also comes to occupy the interpeduncular space and further enlargement in this situation results in displacement backwards of the midbrain as a whole and widening of that part of it which is composed of the cerebral peduncles. This movement and distortion may force the peduncles upon the sharp free margins of the tentorium. The free margin of the tentorium on each side passes from the anterior clinoid process backwards and very slightly outwards to round the midbrain, then curves inwards and upwards towards the midline (*Fig.* 21). There is not much clearance where the midbrain is widest, and behind this point the opening in the tentorium diminishes rapidly in width. Thus when the widened midbrain is moved backwards it soon becomes jammed in the opening (*Figs.* 22, 23).

Instead of rising upwards behind the chiasma, the growth may pass in front of it and between the optic nerves, as in *Case* 8 (*Fig.* 24). It tends then to push on upwards and forwards between the medial surfaces of the frontal lobes, and backwards towards the third ventricle. The optic nerves become greatly stretched, flattened, and displaced, so that instead of converging to meet the chiasma near the midline they pass from the optic foramina upwards and directly backwards, or even outwards. The chiasma is also stretched and flattened and eventually pressed back against the internal capsules and into the third ventricle. At the same time the lamina terminalis

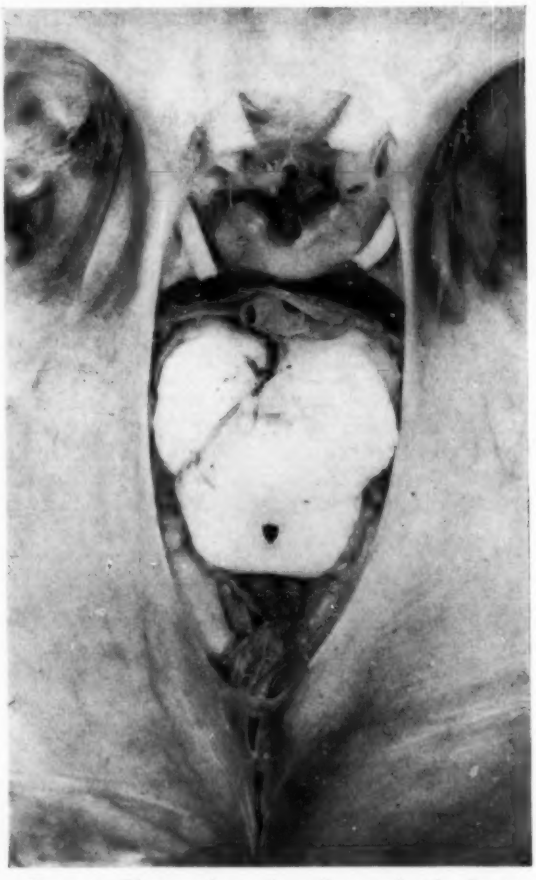

FIG. 21.—Photograph to show the opening in the tentorium and related structures as seen from above. Note that the free margins of the tent are most widely separated opposite the midbrain, and that as they pass backwards they curve towards the midline so that the space between them rapidly diminishes. Part of the cerebellum is seen between the midbrain and the free margins of the tentorium. Note how the third nerves pass lateral to the posterior clinoid processes to pierce the triangular area in the roof of the cavernous sinus, between the 'ligaments'. The upward sweep of the free margins of the tent as they pass backwards is not brought out in this photograph.

and the supra-optic part of the hypothalamus are pressed backwards into the ventricle. Higher up the tumour bears on the lamina rostralis, stretching it and gradually forcing the rostrum of the corpus callosum upwards and forwards, away from the region of the fornix and the anterior commissure, which it thrusts backwards. Laterally on each side

the growth comes to bear upon the parolfactory area overlying the head of the caudate nucleus, and in time may bring about a separation of the caudate nuclei of more than an inch. Finally the tumour, capped by the attenuated lamina rostralis, may bulge into the frontal horn of the lateral ventricle.

Soon after passing the chiasma and optic nerves the adenoma comes in contact with the arterial arch, which is made up of the two anterior cerebral arteries connected by the short anterior communicating artery. This structure offers considerable resistance to the march of the invader and makes a groove crossing its anterior surface from side to side (*Figs.* 18, 24). Further growth forwards of that portion of the adenoma lying below the arterial arcade results in the formation of a nodule lying

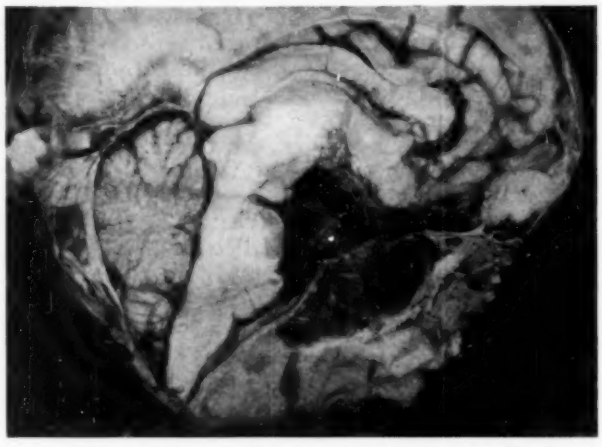

FIG. 22.—Photograph to show the deformity and displacement of the midbrain brought about by the pressure of two intracranial extensions of a pituitary adenoma (*Case* 4). The mesencephalon is displaced backwards and upwards so that the quadrigeminal plate is in close contact with the splenium of the corpus callosum, which in turn is in apposition with the free edge of the falx. Even the cerebellum appears to be compressed from before back.

embedded between the medial surfaces of the hemispheres, just in front of the parolfactory areas.

Sometimes a forward extension instead of keeping to the midline may veer to one or other side. It is then likely to enter the posterior end of the olfactory sulcus, and to break through into the anterior horn of the lateral ventricle (*Fig.* 33). Here it will increase in size rapidly, thrusting the head of the caudate nucleus outwards and backwards. In time the tumour reaches the foramen of Monro and may send a process through into the opposite lateral ventricle.

Upward extensions do not always leave the sella turcica by way of the aperture in the diaphragm. The reader will remember how adenomata of the pituitary gland tend to expand laterally and to bulge into the cavernous sinus on each side. Sooner or later the tumour comes to fill the sinus and in its blind urge to press on it stretches the walls of its prison, walls which were not designed to withstand high and persistent pressure. The progress of the growth beneath the dura mater of the middle fossa has been described. Consider now the roof of the sinus (*Fig.* 21). Passing almost directly backwards from the anterior clinoid process is the strong ligamentous attachment of the tentorium. Crossing obliquely beneath it is the petro-clinoid ligament, which is a thickening in the dura mater passing from the free margin of petrous bone to the dorsum sellæ and the posterior clinoid process. Between the

FIG. 23.—Diagrammatic representation of the tumour in *Case* 4. On each side there is an extension into and beyond the cavernous sinus, passing beneath the Gasserian ganglion as far as the foramina of exit from the skull of the branches of the fifth nerve. On each side again there is an upward extension which has escaped from the sinus at the point of entry of the third nerve. The nodule on the right side is larger and sends a process (not shown) beneath the free edges of the tentorium into the cerebellar fossa. This process passes laterally above the fifth nerve, which is indicated by the interrupted lines. The midbrain is displaced backwards so as to become grasped by the converging margins of the tentorium.

clinoid processes the dura mater dips downwards and is slightly thickened to form the so-called interclinoid ligament. This structure passes obliquely from the anterior clinoid process backwards and medially to the posterior clinoid process. It lies in the roof of the cavernous sinus, which it strengthens,

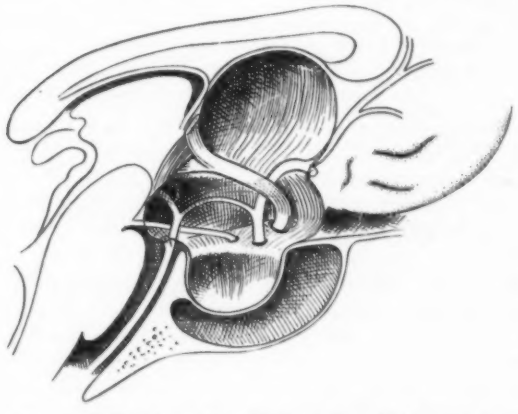

FIG. 24.—Sketch to show the bed of a pituitary adenoma in the left half of the brain, in *Case* 8. The large intracranial extension rose in front of the chiasma, but behind the anterior communicating artery. It displaced the rostrum of the corpus callosum upwards and forwards, and pressed the heads of the caudate nuclei laterally. Compare *Fig.* 17 C.

and is crossed on its upper surface by the carotid artery, which passes backwards, slightly laterally and upwards from the point at which it pierces the roof of the sinus. The artery thus serves to reinforce the ligament and bar the way in this region. The dura mater immediately to the medial side of the artery and ligament is thin, and here infrequently a tumour bud may break through from below.

The dura mater roofing in the sinus in the triangular area bounded by the three 'ligaments' is very thin, and here it is pierced by the third nerve. This nerve passes through a slit-like opening, which is much larger than the nerve itself, and carries in with it a thin fragile sleeve of dura, much as does the fifth nerve from the posterior fossa, to form Meckel's cave. A probe may be passed into this sleeve, alongside the nerve, for about 5 mm. This is an obvious weak spot which will be found by a prisoner striving to escape from the sinus. It is not difficult to imagine that as a tumour in the sinus increases in bulk, it will stretch the thin triangular part of the roof and cause the slit to gape, and before long will send a bud through the opening (*Fig.* 25).

FIG. 25.—Sketch to show the bed of the tumour in the right half of the specimen in *Case* 4. A large downward extension almost filled the sphenoidal sinus, the lateral wall of which is still largely intact. Laterally the tumour entered the cavernous sinus, passing on both sides of the carotid artery to reach beneath the Gasserian ganglion as far as the foramen ovale. The tumour broke through the roof of the sinus at the point of perforation of the roof by the third nerve. The latter was flattened so as to measure 8 mm. in width and stretched in passing round the lateral aspect of the tumour so as to measure 5 cm. in length. The nerve continued to function almost normally. The optic tract is just seen in the roof of the cavity. The fifth nerve in the posterior fossa was displaced and distorted by a process of the extension which passed laterally beneath the tentorium. Note how the nodule pressed into and deformed the right cerebral peduncle and displaced the whole midbrain posteriorly so that the quadrigeminal plate and the splenium of the corpus callosum were brought together in close proximity with the margin of the falx. The anterior choroidal artery is shown in the lateral wall of the tumour bed.

The tiny bud, at first no larger than a pepper corn, may rise directly under the third nerve, but is more likely to thrust it to one side. As the nodule grows the nerve is stretched, flattened, and displaced. Normally the nerve passes from its point of exit from the midbrain forwards and outwards to reach the opening in the roof of the sinus. Its length between these points is about 2·5 cm.

A tumour such as those depicted in *Figs.* 24, 25 may displace the brain-stem backwards and cause the third nerve to pursue a roundabout course measuring 5 cm. or more. At the same time the nerve is flattened to resemble a thin ribbon measuring up to 8 mm. across. That a nerve so maltreated should continue to discharge its duties gives no small cause for wonder.

When the nerve passes over and around the tumour on its lateral aspect, it has finally to cross the ligamentous attachment of the tent, and turn sharply downwards to enter the sinus (*Fig.* 25). This would seem to be the point at which it might suffer mortal damage.

If on the other hand the nerve is displaced inwards by the growing tumour, as in *Figs.* 26 B, C, and 27, it would scarcely escape injury during a surgical attack upon the growth.

As regards the blood-vessels in the vicinity, the carotid artery lies close to the third-nerve aperture, so that before long the issuing tumour will come in contact with it and in all probability will rise between the posterior communicating artery on the inside and the anterior choroidal artery on the outer side (*Fig.* 26). The latter artery may form an obstacle for the surgeon in any attempt to approach the growth from the outer side, whilst the posterior communicating artery, which may be thrust as far as or even across the midline, may be wounded during an operation from the front.

Continuing to rise upwards the extension next encounters the optic tract, near its point of junction with the chiasma. The tract may be thrust upwards so as to pass over the dome of the tumour (*Fig.* 27) or the growth may slip by on its inner side and from then on progress in much the same way as a midline extension rising behind the chiasma (*Fig.* 26 A).

In addition to expanding upwards, the nodule, as usual, tends to spread in all other directions. In front of it lie the carotid artery and its branches, and these serve to hinder progress in this direction. On its outer side the growth bulges over the free edge of the tent, and presses into the temporal lobe, sometimes carrying the third nerve before it, as described above. Towards the midline the extension passes along the upper surface of the diaphragm, beneath the chiasma and optic tract, and thrusts the tuber cinereum before it. It may be held up by a fellow intruder which, having escaped elsewhere at at earlier date, is first in the field (*Fig.* 23).

As it enlarges backwards the growth encounters the cerebral peduncle, which it displaces and indents. Even before this happens it passes across the petroclinoid ligament and finds the way clear to spread downwards along the basilar groove and even laterally below the tent. Here it may come in contact with the fifth nerve, as depicted in *Fig.* 25.

The distance between the medial surfaces of the two temporal lobes is not much more than 1 in., and so it is inevitable that tumours growing between them sooner or later come in contact with one, or both. Centrally placed growths, such as those represented in *Figs.* 20 and 24, do no more than indent the surface of the lobe in the region of the uncus and anterior part of the hippocampal gyrus, perhaps pressing an optic nerve, or tract, or the posteriorly going branches of the carotid artery, against it. Lateral extensions beneath the dura mater of the middle fossa cause it to bulge into the medial and under aspect of the temporal lobe, near its tip. The disturbance of the lobe is not great and will not be considered further. Supradiaphragmatic extensions,

whether escaping in the midline, or through the roof of one or other of the cavernous sinuses, may send a major process laterally, so that in time it comes to occupy much of the middle fossa. In its progress the process will in all probability pass above the third nerve and most likely below the posterior communicating artery and the anterior choroidal arteries. These structures, and the optic tract, must perforce adapt themselves to the new state of affairs. On is enlarged, the pressure upon the remaining intact walls falls, until expansion of the growth is checked again by some other obstruction. Then once more the pressure mounts until a further break through is effected.

Suppose now that an adenoma emerges from the sella turcica in the first instance by way of the aperture in the diaphragm. Gradually the opening is enlarged until it may measure 2 cm. in diameter.

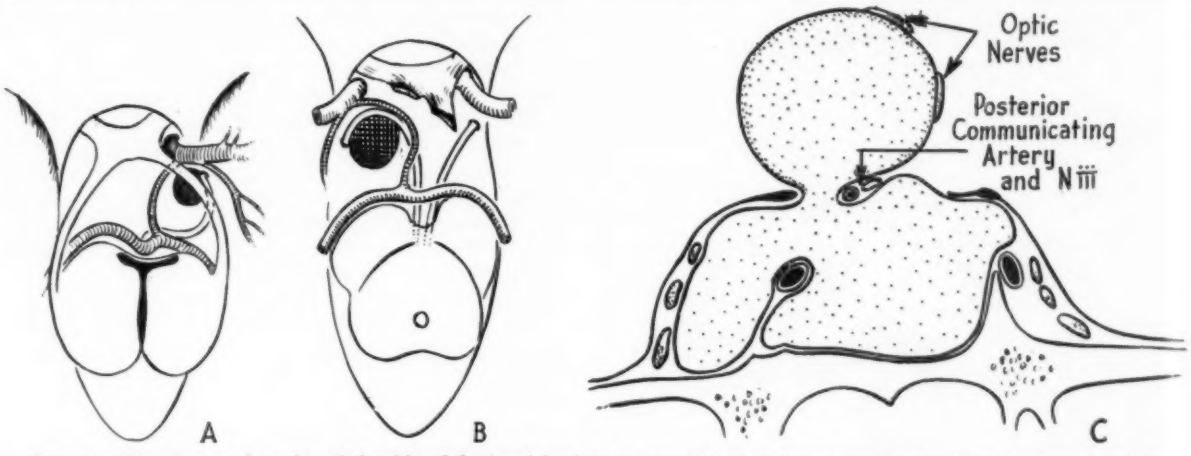

FIG. 26.—Diagrams to show the relationship of the 'neck' of the intracranial extension to nearby structures in *Cases* 9 and 10. In each case the tumour escaped from the cavernous sinus alongside the third nerve. In *Case* 9 the nerve was thrust laterally and the emerging tumour then passed upwards between the anterior choroidal artery on the outer side and the posterior communicating artery on the inner side (A). It then passed to the inner side of the optic tract and continued to enlarge in the embrace of the optic tracts, thrusting the midbrain backwards. In *Case* 10 (B, C) the third nerve and the posterior communicating artery curved around the inner aspect of the neck of the tumour and lay practically in the midline.

reaching the temporal lobe, in the region of the anterior part of the hippocampal gyrus, the tumour may either thrust the brain before it, or burrow into it. The photographs (*Fig.* 31) show how a massive extension into the left middle fossa has compressed the temporal lobe and displaced the basal nuclei, internal capsule, and cerebral peduncle upwards and to the right. In *Fig.* 32 the photographs show how a very large supradiaphragmatic extension of a pituitary adenoma has entered the left temporal lobe by way of the hippocampal fissure and come to occupy the temporal horn of the lateral ventricle. Again there is great displacement of the basal nuclei and cerebral peduncle. In this case the tumour is not in contact with the dura mater of the middle fossa. Unfortunately the two specimens from which these photographs were taken were not dissected, and the relationships of the tumours to the cranial nerves and vessels were not recorded.

The manner of spread of tumours of the pituitary gland in various directions has been described. It remains to consider in what combinations the various extensions may occur. It has been pointed out that an adenoma in growing tends to spread in all directions radially from its point of origin, and, if unimpeded, to keep a spherical shape. In the sella turcica, however, it is not unimpeded for long, and when it has taken up all available space, it needs must strive to break through the confining walls. As long as these hold fast, the tumour exerts a steadily increasing pressure against them from within, but when the defences give way at any weak point it breaks through and advances rapidly into an area of low resistance. As the breach in the walls The diaphragm ceases to impede the march of the growth and no longer provides a *point d'appui* from which pressure may be brought to bear on the floor and lateral walls of the pituitary fossa. In such a case the intrasellar portion of the tumour remains stationary whilst the suprasellar extension undergoes rapid enlargement (*Figs.* 18, 20, 24). If, on the other hand, the floor of the fossa gives way first, the adenoma moves onwards into the sphenoidal sinus, eventually filling it and sooner or later breaking out laterally on one or both sides, as described above. Only much later is it likely to break through the diaphragm or the roof of one or other of the cavernous sinuses (*Fig.* 26 C). Thus it comes about that large tumours often consist of a major subdiaphragmatic portion and a minor supradiaphragmatic portion, or vice versa. Just what factors operate to determine the site of the early break through is not clear.

INVESTIGATION OF A CASE OF PITUITARY ADENOMA

It is one thing to know something about the various ways in which a pituitary tumour may expand beyond the confines of the sella turcica, but quite another to determine just what is the state of affairs in any particular case. Without accurate knowledge the surgeon is not able properly to plan an attack upon the tumour, and success is unlikely to attend his efforts.

Information is obtained from the clinical examination, and from radiography of the skull, pneumography, and angiography.

Clinical Features.—There are so many important structures in the immediate vicinity of the sella

turcica that it would seem that a tumour arising there, of all places, must produce, as it increases in size, a sequence of tell-tale signs and symptoms which would enable the clinician to make a shrewd estimate of the size, shape, and relationships of the growth. In practice, however, it is by no means easy to do so. This is so because structures such as cranial nerves, nerve tracts in the midbrain, and centres in the hypothalamus often continue to function normally even though subjected to pressure by the growth,

FIG. 27.—Sketch to show the tumour bed in the left half of the brain in *Case* 10. Below the diaphragm the tumour almost filled the sphenoidal sinus. There was an extension which passed laterally over the carotid artery into the cavernous sinus and beyond. The bony lateral wall of the sphenoidal sinus was deficient except in its antero-inferior part. The tumour escaped through the roof of the cavernous sinus alongside the third nerve, which was displaced so as to come to pass, in company with the posterior communicating artery, around the 'neck' of the tumour on its medial aspect. Having escaped from the sinus the growth extended upwards so as to press into the brain in the region of the anterior perforated substance. Laterally it indented the medial surface of the temporal lobe, the anterior choroidal artery lying in between. It pressed into the left cerebral peduncle from the outer side displacing the midbrain backwards and to the right. This produced a right-sided hemiparesis. Note how the splenium of the corpus callosum and the quadrigeminal plate are pressed towards the falx. The left optic tract coursed over the dome of the tumour.

and such interference with blood-vessels as may occur usually goes unheralded.

In this series almost all of the patients with large tumours exhibited some of the signs and symptoms of deficiency of pituitary secretion, and histological examination showed the growths to be composed in the main of chromophobe cells. There seems, however, to be no reason why eosinophilic growths associated with acromegaly should not attain to a large size. In any case the signs and symptoms in question do not help the clinician to picture the size, shape, and relationships of the offending tumour.

In those cases in which there was severe pressure upon and deformity of the hypothalamus, as depicted in *Figs.* 18, 19, 20, and 25, drowsiness was usually a well-marked feature, but the value of this symptom in localization is somewhat diminished because it was present in other cases in which the hypothalamus did not appear to be seriously disturbed. Changes in personality and dulling of mentality were usually present when there was a massive intracranial extension in any situation. In such a case it may be difficult to decide whether the changes are due to interference with the functions of the hypothalamus or frontal lobes, or to the development of hydrocephalus. True narcolepsy as distinct from drowsiness would suggest involvement of the hypothalamus. Diabetes insipidus was conspicuous by its absence.

Hemiparesis was uncommon and was due as a rule to direct pressure of the growth upon one or other cerebral peduncle, but in several cases in which these structures were subjected to a moderate degree of pressure there was no evident loss of function. It has been pointed out above that the peduncles may be pressed against the free edge of the tentorium. In this way, presumably, a tumour lying chiefly to one side of the midline might cause paresis of the same side of the body.

The cranial nerves in the region were commonly pressed upon and distorted by the tumour, but more frequently than not there was no obvious loss of function. In *Case* 9 (*Figs.* 23, 25) the third nerves were both much stretched, flattened, and displaced. That on the right side measured 8 mm. in width at its widest point, and 5 cm. in length from its point of emergence from the midbrain to its point of perforation of the roof of the cavernous sinus, where it was sharply bent over the ligamentous attachment of the tentorium. The average length of the section of nerve in question is about 2·5 cm. There was slight inequality in size of the pupils, but no other sign of third-nerve paralysis. The fifth nerves were both distorted by extensions of the tumour into and beyond the cavernous sinuses and in addition that on the right was much deformed and stretched by a nodule of tumour in the posterior fossa. There was no complaint of pain, and no loss of sensation in the face.

In *Case* 10 (*Figs.* 26 B, C, and 27) the third nerve on the left side passed around the neck of the intracranial extension of the tumour on its medial aspect. Paresis of some of the muscles supplied by the nerve became evident only a short time before the patient's death, although it is clear that the nerve must have been compressed and distorted for a very long time.

In several of the specimens examined the tumour was found to have invaded the cavernous sinus, usually on both sides (*Figs.* 11, 14, 23, 26 C). None of the patients from whom the specimens were obtained had, during life, exhibited any signs to indicate that the sinuses had ceased to carry blood, and nerve palsies were conspicuous by their absence; nor was pain in the region supplied by the fifth nerve encountered, excepting in one case. It would seem that invasion of the cavernous sinus is not uncommon and that it may, and usually does, occur without causing any very characteristic signs and symptoms. On the other hand the occurrence of anæsthesia dolorosa in the field of the fifth nerve, together with ocular palsies, would indicate trouble in the cavernous sinus. In no instance was loss of function of the fourth or sixth cranial nerves detected during life, although the nerves were often distorted by lateral extensions of growths.

Interference with the sense of smell was detected in a few instances and later this was found to be due to pressure of an intracranial extension on an olfactory tract or trigone. In some cases, however, in which it was later possible to demonstrate involvement of the olfactory apparatus, no loss of the sense of smell was detected.

It might be expected that an examination of the visual acuity and fields of vision would give valuable information as to the size and position of the offending tumour. This is indeed so in many instances, but it must be remembered that sometimes quite small growths cause serious loss of vision (*Figs.* 9, 16) whilst occasionally those of much larger dimensions do not. In addition, in the late stages, when but little or no vision remains, it may be impossible to deduce, from this evidence alone, what is the relationship of the growth to the nerves in question. Frequently, however, the detection of bitemporal hemianopia, unilateral blindness, homonymous

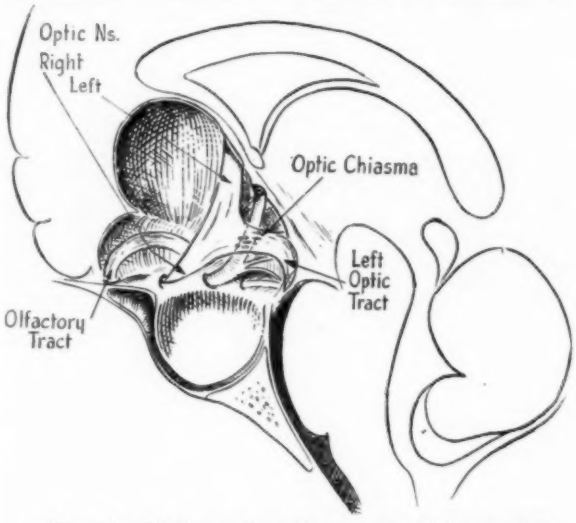

FIG. 28.—Sketch to show the tumour bed in the right half of the specimen obtained in *Case* 11. Below the level of the diaphragm a nodule measuring about 2·5 cm. in diameter occupied the greater part of the sphenoidal sinus. The bony floor of the sella turcica and the lateral walls of the sphenoidal sinus had been largely removed by the growth. The tumour escaped upwards from the sella turcica in the midline and sent a large lobulated process forwards and upwards between the frontal lobes. The genu of the corpus callosum was thrust upwards, but there was no great displacement of the brain-stem. The olfactory tract was stretched and flattened, and pressed against the bed of the tumour in the medial aspect of the frontal lobe. The right optic nerve was sharply bent at the optic foramen and passed outwards, upwards, and slightly backwards to reach the chiasma. The latter lay well to the right of the midline, and was flattened from side to side and rotated so that its left extremity came to lie directly above its right. The left optic nerve curved over the dome of the tumour. A portion of it is shown in this sketch. The right optic tract is scarcely seen. The left curves around the posterior aspect of the tumour. The right anterior cerebral artery crossed the flattened chiasma on its outer aspect, and by its pressure caused a thinning of such degree that in places there were small perforations in the nerve. The patient was almost blind, the vision that remained being confined to the right nasal field.

hemianopia, or some other defect in the fields of vision, suffices to justify the making of a diagnosis of the location of the tumour. Unfortunately in several of the cases from which specimens were obtained and studied no recent detailed notes of the state of the function of vision were available.

Radiography.—Unlike craniopharyngiomas, pituitary adenomas seldom contain deposits of radio-opaque material and thus they are not visible in plain radiographs. Some information as to their size and position may be gained by observing changes in the appearance of the bones of the skull in the region, and the position of the pineal gland, if and when it is calcified. The information so gained may suffice to give a very good notion of the state of

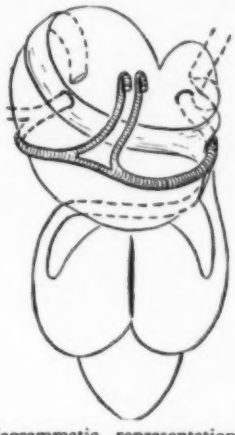

FIG. 29.—Diagrammatic representation of the supra-sellar extension of the tumour in *Case* 11, as seen from above, to show some of its relationships. Note the extreme degree of stretching and displacement of the left optic nerve and the left optic tract, and the position of the optic chiasma. The left optic nerve measured approximately 8 cm. in length and 1 cm. in width at its widest part. Note how the anterior cerebral vessels and the anterior communicating artery embrace the tumour.

affairs below the diaphragm, but not, as a rule, of the position above it.

Whilst the floor of the sella turcica is still intact, there is little difficulty in estimating the size of the subdiaphragmatic portion of the growth, although it is not possible to demonstrate whether it has spread laterally to invade the cavernous sinuses or not. After the floor has been destroyed, the tumour spreads into the sphenoidal sinus and its outline may be clearly seen in lateral views, so long as there is still air in the sinus. Later the absence of air suggests that the sinus is completely filled by the growth.

The lateral walls of the sphenoidal sinus are difficult to see in radiographs of the skull, and thus it is not usually possible to demonstrate either partial or complete destruction of the bone in this region. It should not be difficult to demonstrate erosion of bone in the floor of the sphenoidal sinus, and in the region of the foramen lacerum, tip of the petrous, foramen ovale, and superior orbital fissure (*Fig.* 15).

Displacement upwards and backwards of a calcified pineal gland would suggest the presence of an intracranial extension pressing upon the midbrain (*Figs.* 14, 22, 27).

Pneumography.—Air studies often yield valuable information and should be undertaken in all cases prior to operation. If the pressure of the cerebrospinal fluid, as determined by manometry, is not unduly high, encephalography should be employed in an endeavour to depict the basal cisterns, the third and lateral ventricles. Air is introduced in the usual way through a needle into the subarachnoid space in the lumbar region, with the patient in the sitting posture, his neck and head extended. A series of radiographs is taken during

the introduction of the air, and finally any other views which may seem to be desirable are obtained.

Ventriculography is resorted to in those cases in which encephalography either is not advisable or fails to give satisfactory information.

Large intracranial extensions of adenomata arising in the pituitary gland usually encroach upon the

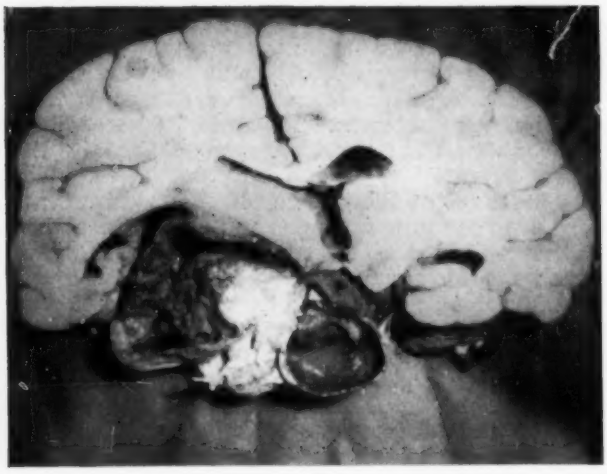

FIG. 31.—Photographs to show a large extension of a pituitary adenoma into the left middle fossa. The growth has compressed the temporal lobe, and thrust the basal nuclei and cerebral peduncle upwards and to the right. Much of the tumour is visible in the basal view (*Case* 12).

cisterns in the region to such an extent that these cannot be demonstrated by encephalography. Often, however, gas collects about the periphery of a tumour and may serve to outline parts of its surface. By noticing these abnormal shadows, and the absence of shadows which should be present, the radiologist is able to make a shrewd estimate of the size and position of the growth.

If the tumour has grown upwards and backwards in the midline, as depicted in *Figs.* 18, 20, ventriculography will show that the lateral ventricles are dilated and, unless there is a perforation of the septum pellucidum, do not communicate. In such a case there is likely to be a difference of pressure in the two lateral ventricles, and the septum is seen to bulge into that in which the pressure is lower. The

FIG. 30.—Sketch to show the bed of the tumour in the left half of the specimen (*Case* 11). The greater part of the growth lay in this half. A portion of the left optic nerve is shown passing from the optic foramen forwards and slightly outwards before it curves upwards over the dome of the tumour. The left anterior cerebral artery, passing almost vertically upwards on the lateral aspect of the tumour, the anterior communicating artery and part of the right anterior cerebral artery, are depicted. The left optic tract is seen lying posterior to the tumour.

third ventricle is not visualized. The dome of the tumour may sometimes be made out in both anteroposterior and lateral views, in the region of the foramina of Monro.

When the tumour has kept to the midline but lies farther forward, as shown in *Figs.* 24, 28, 30, air may be introduced by either the lumbar route or directly into the lateral ventricles. The third ventricle may be seen, at least in part. The tips of the frontal horns are compressed so that they contain little or no air and are not well seen. The heads of the caudate nuclei are seen in the anteroposterior view to be widely separated, their outlines, instead of converging so as to meet if produced downwards in the

midline, about the level of the floor of the third ventricle, running parallel or even diverging (*Fig.* 34).

In those cases in which the tumour has veered to one side of the midline so that it comes to press

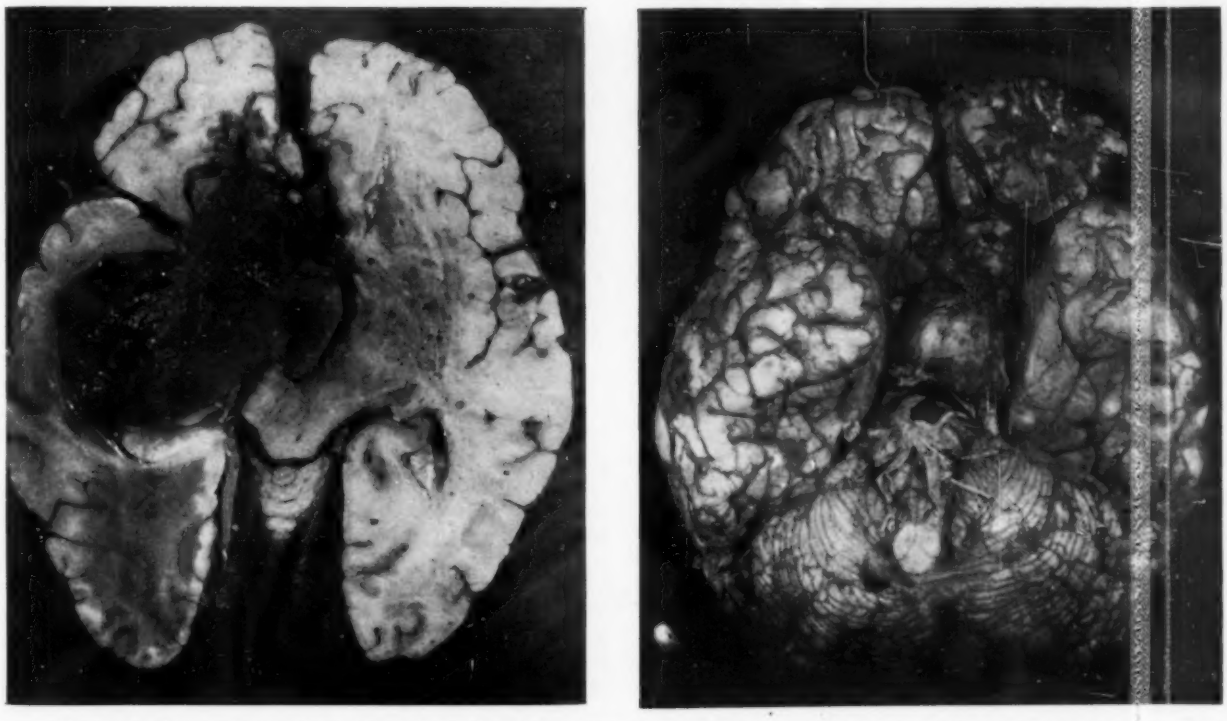

FIG. 32.—Photographs to show how a large lateral extension of a pituitary adenoma has entered the temporal lobe by way of the hippocampal fissure and come to occupy the temporal horn of the lateral ventricle. Note that in the basal view the temporal extension is not seen (*Case* 13).

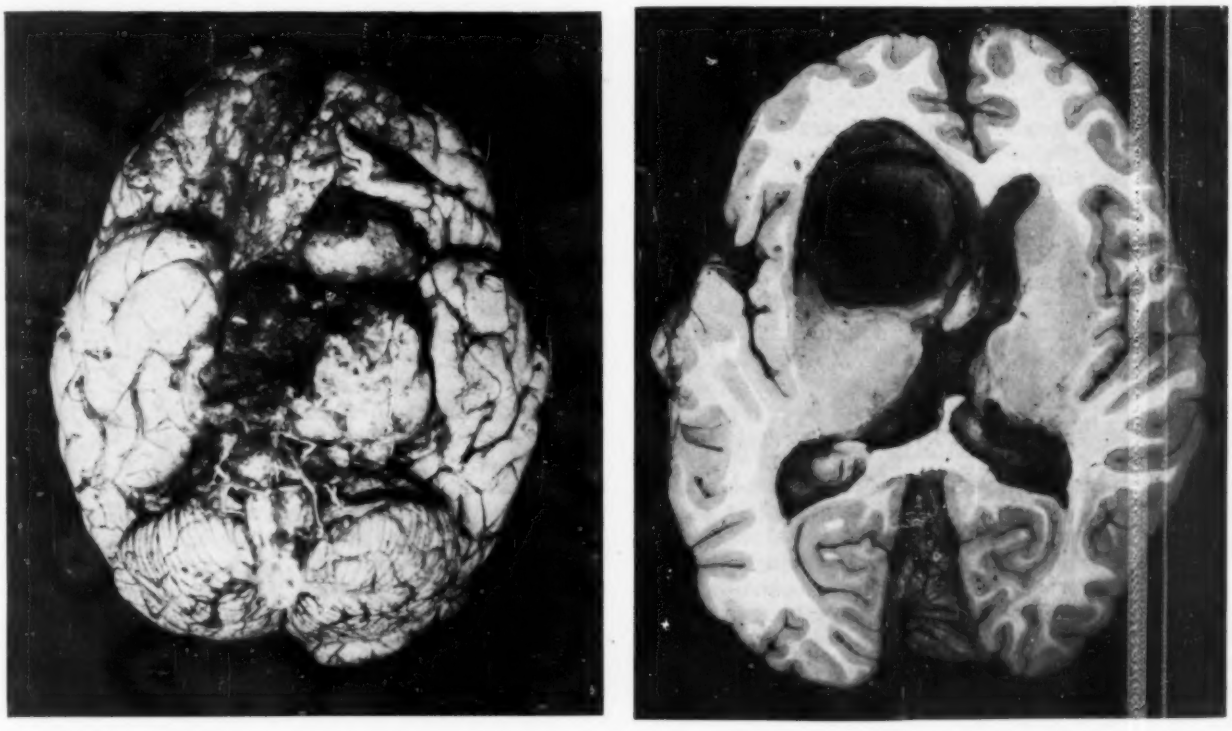

FIG. 33.—Photographs to show how a large pituitary tumour has sent an extension into the under-surface of the frontal lobe in the region of the olfactory trigone (*Case* 5). It has come to occupy the frontal pole of the left lateral ventricle, displacing the head of the caudate nucleus backwards. Another large process has compressed the left temporal lobe.

into the brain in the region of the anterior perforated substance, the third ventricle may sometimes be seen to be displaced towards the opposite side. The corpus striatum is displaced upwards and thus the floor of the anterior part of the lateral ventricle lies at a higher level than that on the other side. Should the tumour insert itself into the olfactory sulcus, it may force its way into the frontal pole of the lateral ventricle and develop into a globular mass. It thrusts the caudate nucleus laterally and backwards and may send a process into the foramen of Monro, thus blocking the flow of cerebrospinal fluid (*Fig.* 33). In such a case ventriculography will show that the opposite lateral ventricle is dilated in its whole extent. There may be an indication of the presence of the tumour bulging the septum pellucidum into it. The lateral ventricle on the side of the tumour is also dilated in its posterior part, but anteriorly the shadow is defective and the curved outline of the intraventricular tumour is clearly seen.

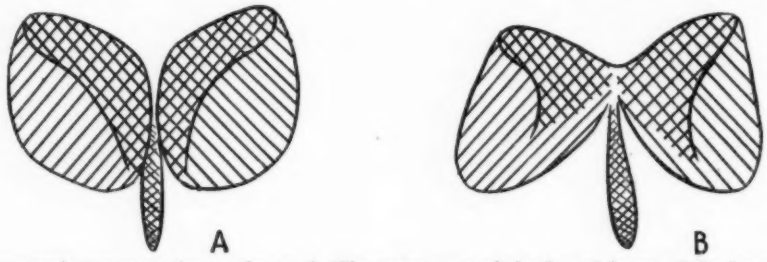

FIG. 34.—Diagrammatic representation to show: A, The appearance of the frontal horns of the lateral ventricles and the third ventricle in a normal brain; B, When a tumour such as is represented in *Figs.* 27–29 is present.

Large extensions into the anterior part of the middle fossa of the skull, such as are depicted in *Figs.* 31, 32, compress the temporal horn of the lateral ventricle so that it cannot be filled with gas, and cause a 'shift' and deformity of the ventricular system as a whole, which is similar to that caused by other large tumours in this situation.

Angiography.—Angiography was not employed in the investigations of any of the cases in this series. There is no doubt that had it been used, it would have given most valuable information, not only as regards the location of the tumours, but also of the disposition of important vessels in relation to the growths. Information of this nature would be of great value to the surgeon in planning and executing an operation.

THE SURGERY OF LARGE PITUITARY TUMOURS

In the foregoing parts of this paper consideration has been given in general to the ways in which pituitary tumours may spread and the effects of certain extensions upon various structures in the neighbourhood. The problem of estimating the size, position, and relationships of the growth in any particular case has received some attention. An attempt must now be made to apply the knowledge so gained, in planning the surgical approach to the growth and, if possible, its removal.

It will be convenient to consider in the first place the subdiaphragmatic portion. When this remains confined to the sella turcica, albeit a somewhat enlarged sella turcica, subtotal intracapsular removal along the lines usually advocated in surgical textbooks is not difficult. Total removal is scarcely possible, or even desirable, as too thorough curettage would in all probability result in destruction of the remains of the pituitary gland. When the growth has broken through the floor of the sella and come largely to fill the sphenoidal sinus, it is difficult to effect from above even a subtotal removal and there is a real danger of tearing through the capsule and mucoperiosteum of the sinus and so establishing a track along which cerebrospinal fluid may leak into the nasopharynx and bacteria may gain entry to the meningeal spaces. Even more difficult is the removal of lateral subdural extensions such as are depicted in *Figs.* 12, 19, 23, and 26 C. Here, in addition to the difficulties of access, which are considerable, there is not only the risk of wounding the carotid artery and the sixth nerve, which are likely to be buried in the growth, but also the various nerves which lie in the 'roof' of the space.

A fully developed subdiaphragmatic extension, which has filled the sphenoidal sinus, destroyed its lateral walls, and spread beneath the dura mater as far as the foramen ovale on each side, does not, as a rule, cause the patient any great inconvenience. There is a danger that infection from the nasopharynx may spread into and through the growth, but nothing the surgeon can do is likely to improve matters in this respect.

There is thus no very good reason why any attempt to effect a total or subtotal removal should be made and there are good reasons for not doing so. Removal of much of the central portion of the mass, in the sphenoidal sinus, by curettage and suction, is, however, often possible, and this should be attempted. If successful, the manœuvre should result in a diminution, for a time at least, of the pressure of the tumour upon the confining walls, and postponement of the day when there will be a breaking through into the nasopharynx, orbit, and elsewhere.

Extensions above the diaphragm differ from those beneath it, in that they tend, sooner or later, to incommode the patient very much, and in the end to destroy him. Obviously these should be tackled whilst they are still small and have not caused irreparable damage, but it is assumed that the favourable moment for intervention has passed, and that the surgeon is faced with the problem of dealing with a large mass. He may be called upon to operate for various reasons. In the first place vision may be failing. It may be that this failure is of recent date, and not very advanced, so that there would

seem to be hope of preserving useful sight by means of surgical intervention. On the other hand, the patient may be blind, or nearly so, and this argument would not apply. In the latter case the surgeon would feel free to sacrifice an optic nerve, or other part of the visual apparatus, in order to facilitate extirpation of the tumour.

Sometimes there is severe pain in the region of the face. More often large growths bring about grave changes in mentality and personality, by interfering with the functions of the hypothalamus and frontal lobes. Epilepsy is not uncommon. Eventually the intracranial pressure rises, either as a result of the great bulk of the growth, the development of hydrocephalus, or both, and menaces the life of the patient. These troubles, arising singly or in combination, may impel the surgeon to attempt to remove the tumour.

Access.—It is obvious that the trans-sphenoidal approach is unsuitable for dealing with large intracranial extensions. The right frontal approach, with elevation of the frontal lobe, provides adequate exposure for the removal of much of the subdiaphragmatic portion of the growth, and of some extensions of moderate size above the diaphragm. In dealing with such a nodule it is the custom to make an incision in the capsule where it is visible and, keeping strictly within the capsule, to remove much of the substance of the mass by the use of suction, punches, and so on. It may then be possible to coax the capsule away from its surroundings, to pull it forwards into view, and to remove it.

When, however, the extension is of large dimensions, buried deeply in the brain and presenting but a very small area of its surface to the view of the surgeon, the method is not adequate. In order to remove enough of the central portion of the nodule to permit of infolding of the peripheral part, the surgeon would have to pass his instruments as it were around the corner, out of sight, in directions and for distances at which he could only guess.

In order that the preliminary intracapsular removal of the tumour may be effected without undue risk, it is essential, in the first place, to expose to full view an adequate area of its surface. This should measure not less than an inch in diameter, and more if possible. A tangential view is not good enough. The various approaches to tumours in different situations are discussed later. A satisfactory surface having been exposed, the capsule is incised, and with the aid of curettes, punches, and suction, the soft cellular material of the growth is carefully removed. Finally the capsule, rendered mobile by the removal of most of the tumour, is drawn away from its surroundings, until the region of the diaphragm is reached. Great care is necessary during this part of the dissection, in order that important vessels and nerves, which may be not easily recognizable, may be preserved from harm.

It may happen that the dangers of removing the capsule in places are so great that some of it must be left behind.

After the tumour has been removed down to the region of the diaphragm, a careful intracapsular removal of the central part of the subdiaphragmatic portion is undertaken.

The steps to keep in mind are first to obtain a good exposure of the surface of the large supradiaphragmatic nodule, secondly to remove it as described above, and thirdly to make use of the space so provided to effect an intracapsular removal of the intrasellar portion of the tumour.

Some consideration must now be given to the methods to be adopted in order to expose a suitable area of the surface of tumours in various situations.

1. *The tumour has grown upwards and backwards in the midline, rising behind the optic chiasma as in Fig.* 20 : Here the chiasma crosses the anterior aspect of the tumour a short distance above the tuberculum sellæ, and a little higher up lies the arterial arch made up of the anterior cerebral arteries and the anterior communicating artery. The anterior aspect of the growth between the optic chiasma and the anterior commissure is covered by the inverted and very much thinned-out floor of the third ventricle and the lamina terminalis. There is very little space between the chiasma and the tuberculum sellæ, and any attempt to deal with the mass through it is doomed to failure.

In order to provide direct access, part of the frontal lobe must be cut away. After turning down a right frontal osteoplastic flap in the usual way and reflecting a flap of the dura mater medially, a section is made through the lobe obliquely in such a way that whilst on the convexity it enters the brain nearly 2 in. from the midline, it is directed towards the medial surface at the genu of the corpus callosum. The incision, however, is not carried quite to the medial and orbital surfaces of the hemisphere. When the severance is almost complete, the white matter of the almost detached fragment is scooped out, leaving but a thin layer of brain covered by its meninges. This layer is then folded over the cut surface of the hemisphere. By proceeding in this way raw surfaces are covered over and the necessity for dividing the vessels in the medial aspect of the frontal lobe is avoided. In addition, retraction laterally of the stump of the lobe is facilitated. Care must be taken not to wound the head of the caudate nucleus or to open into the lateral ventricle. Branches of the right anterior cerebral artery are then found in the region of the genu of the corpus callosum and are followed backwards until the parent artery is reached. This is then doubly clipped and divided, proximal to the point of origin of the anterior communicating artery. It is probably safer to sever the arterial arch at this point than to attempt to divide the anterior communicating artery as there is less risk of damaging the left anterior cerebral vessel, which must be preserved intact at all costs. If, however, the anterior communicating artery is long it may be clipped and divided. In this case both anterior cerebral arteries may be preserved intact.

Next the optic chiasma is defined and divided in or just to the right of the midline, and finally, the thinned-out lamina terminalis and floor of the third ventricle are torn through. The exposure of the tumour should then be sufficient to permit of an attempt to remove it, with some prospect of success.

2. *The tumour has risen in front of the optic chiasma, but behind the arterial arch, as in Fig.* 24 : It lies more anteriorly than in (1). Here the approach is the same as in the first, but the only important

structure lying on the anterior surface of the growth is the arterial arch. This is dealt with by dividing it as described above.

3. *The tumour has grown upwards and forwards, in front of the optic chiasma and the arterial arch, as in Figs.* 28, 30: It lies more anteriorly than those in (1) and (2), and in much the same position as a meningioma of the olfactory groove. The approach is as described in (1). No important structures lie on its exposed anterior surface.

4. *The tumour has risen upwards to one side of the midline, thrusting the optic nerve and chiasma towards the other side, as in Figs.* 10, 17 D, *and pushing upwards into the brain in the region of the posterior end of the olfactory sulcus and anterior perforated substance. It has thrust the head of the caudate nucleus backwards and laterally, and finally broken through into the frontal pole of the lateral ventricle, where it has developed as a globular mass, demonstrable by pneumography* (*Fig.* 33): The surgical approach is by way of an osteoplastic flap in the appropriate frontal region, a flap of dura mater being reflected medially. A cylindrical portion of the brain about 3 cm. in diameter is excised so as to provide a tunnel opening into the ventricle directly over the growth. The latter is then attacked under direct vision in the usual way by the use of suction, the central part being removed in sufficient quantity to permit of infolding of the more peripheral part and the thin capsule. In this way the neck of the tumour at the base of the brain may be reached without much difficulty. At this point great care must be exercised to keep inside the capsule, as the neck is certain to be in close relationship with the branches of the carotid artery on its lateral and posterior aspects, and the optic nerve, chiasma, and tract on its medial aspect. The third nerve will not be far away. The whole of the capsule lying free above the neck may be cut away, but no attempt should be made to free it at the neck from its surroundings. The intrasellar portion of the tumour is then carefully removed piecemeal by curettage and suction. The surgeon is able to look directly through the opening in the diaphragm into the sella and to carry out the necessary manipulations under visual control.

5. *A major process of the tumour has spread laterally into the middle fossa, either thrusting the temporal lobe before it, as in Fig.* 31, *or burrowing into it as in Fig.* 32: Here the approach is by way of a temporal osteoplastic flap, with free removal of bone in the temporal fossa. A portion of the temporal lobe is cut away to expose the surface of the tumour, which is then attacked in the usual way. As the region of the edge of the tentorium and its attachment to the anterior clinoid process is approached, the greatest care must be exercised to avoid injury to the third and fourth nerves, which are likely to lie between the tumour and the dura mater, and the optic tract, which is likely to cross over the growth on its upper aspect. Even more important are the posterior communicating and anterior choroidal arteries, which will in all probability lie cranial to the growth and must not be injured. It would be wise not to attempt to carry the removal further than the clinoid processes.

6. *There are two large extensions of the tumour, one burrowing into the under-surface of the frontal lobe, the other into the temporal lobe* (*Figs.* 32, 33): In this case it is necessary to attack the temporal nodule as described above in (5), and the frontal portion as in (4). It may be possible to tackle both at the one operation, employing a large fronto-temporal osteoplastic flap to expose both the frontal and temporal lobes. The larger extension should be removed first, and the decision then made as to whether the removal of the smaller nodule should be attempted at once, or later, at a second operation.

SUMMARY

An attempt is made to describe how tumours arising in the pituitary gland grow and extend beyond the confines of the sella turcica, and the way in which they affect the surrounding tissues and structures.

The growths may attain to a large size and bring about profound changes in the disposition of the neighbouring structures.

In the second part of the paper are described the methods employed in an endeavour to ascertain the size, shape, and relationships of a large growth in a living patient. Chief among these are the clinical examination, plain radiography, pneumography, and arteriography.

In connexion with the clinical examination, it is pointed out that cranial nerves and other nervous tissues may continue to function very well even though grossly disturbed by the growth.

Finally an endeavour is made to describe the appropriate methods of approach to and removal of large pituitary tumours.

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METASTASIZING GOITRE

'HÜRTHLE CELL' TUMOUR OF THE THYROID AND SKULL

By R. CUNLIFFE SHAW, Preston Royal Infirmary

Metastasizing tumours of the thyroid may be divided into two groups: firstly, those associated with the well-recognized forms of malignant disease of the gland; and, secondly, a rare group of atypical tumours showing metastatic propensities. This latter group were frequently classified as benign metastasizing goitre, a concept that associated the normal thyroid gland or one the seat of a simple goitre with distant metastases which had assumed some of the characteristics of malignant neoplasms. It has been shown that in every case where there is metastasis related to the thyroid in structure, careful examination can detect a tumour in that gland and therefore the atypical metastasizing goitres form a special group themselves belonging to the 'latent cancer' type described by Carrel in 1901. They are all potentially malignant neoplasms in so far as they metastasize sooner or later. A peculiar feature is the occurrence of secondary growths often remote in position located in bone, and which, though locally invasive, may only displace the histological elements around the secondary focus. On the other hand the primary lesion in the thyroid is generally slow growing and of negligible size and clinical import compared with metastases.

Pemberton in 1927 reported that out of 438 cases of untreated carcinoma of the thyroid seen at the Mayo Clinic, 108 had metastases. Of these 69·5 per cent were located in the regional nodes, 24 per cent in the lungs, 16 per cent in the thorax, and 6 per cent in bones, apart from various locations. In contrast to these figures Walter M. Simpson in 1926 examined the so-called benign metastasizing goitres and found that in 73 of 77 cases which he collected from the literature it was the bone tumour which produced the clinical symptoms. The skull was involved in 30, the vertebræ 25, pelvis 11, clavicle 9, sternum 9, femur 9, ribs 7, humerus 7, scaphoid 3, and mandible 2. Clearly there is a profound difference between the pathological progress of the so-called atypical carcinomas of the thyroid and that of the ordinary varieties of malignant neoplasm of the gland.

According to Joll (1932) there are two outstanding types of metastasizing goitre which have been described by Langhans (1911) and these are: (1) the metastasizing struma; (2) the struma post branchialis; and to the foregoing may be added a third type described by the same clinician, (3) the parastruma of Langhans.

The first of these atypical thyroid growths is closely related to the "latent cancer" of Carrel, in which histologically different parts of the tumour reproduce the appearance of the developing normal thyroid, groups of cells being arranged around openings described by Langhans as the "trellis work fields" and by Wegelin as the "sieve-like perforations". Clinically the picture is dominated by the large metastases of fairly rapid growth, the primary tumour being small and inconspicuous.

The second type of metastasizing g[illegible], the struma post branchialis, was attributed by [illegible]ghans and Sophia Getzowa to the activity of rem[illegible]nts of the post-branchial body or lateral thyroi[illegible]nlage. The cells of these tumours are eosinophi[illegible] polyhedral in shape, and arranged in small alve[illegible]. Joll considered these neoplasms to be atypica[illegible]deno-carcinomas.

The third form of metastasizing goitre, [illegible]ermed "parastruma" by Langhans, was attributed [illegible]y him to parathyroid cells embedded in the thyroi[illegible]arenchyma. They consist of 'foam-like' or [illegible]vater-clear' cells arranged in alveolar formation a[illegible]d large eosinophilic cells arranged in trabeculæ arou[illegible] small acinar spaces. These tumours are better kn[illegible]n by the term 'Hürthle-cell tumours' and were regarded by Langendorff and others to arise from the interfollicular cells described by Baber in 1874.

A study of the literature demonstrates considerable dubiety in the description and classification of these types of metastasizing goitre, and the present case is recorded not only on account of its rarity but for several interesting pathological and clinical features which may help towards the elucidation of these obscure lesions.

CASE REPORT

Clinical History.—Mrs. M. B. W., aged 58 years. In July, 1948, complained of a lump over the right fronto-parietal region. Her own doctor diagnosed a sebaceous cyst, which he incised. The tumour at this period was about as large as a walnut and when it was opened there was profuse hæmorrhage and the doctor noted that there was a small hole in the skull. The patient was entirely free from symptoms. A slight swelling in the neck in the region of the thyroid had been observed for over ten years.

On Aug. 3 she was admitted to Preston Royal Infirmary for investigation. A radiograph of the skull showed a deficiency in the right fronto-parietal area. There was a fluctuant tumour in the scalp covering this region about ¾ in. in diameter and raised slightly above the skin level. The cranial margin could be felt at the margin of the tumour. There was a slight enlargement of the left lobe of the thyroid gland which the patient said she had had for over ten years. The gland moved freely on deglutition and there were no other swellings palpable in the neck. Examination of the central nervous system and the urinary and cardiovascular systems were negative. Wassermann and Kahn reactions were negative. An intravenous pyelogram showed normal outlines to both kidneys and ureters and the chest was X-ray negative.

In view of the absence of clinical symptoms it was decided to explore the tumour, which had grown rapidly since it was incised the previous month.

At Operation.—On Aug. 5 the tumour was exposed and removed by diathermy. The opening in the skull was enlarged and the tumour appeared to be growing from the bone and the outer surface on the dura, but there was no evidence that it had penetrated the latter. There was considerable hæmorrhage and at the close of the operation the whole area was thoroughly cauterized and the skin-flap replaced.

THE SPECIMEN.—Professor M. J. Stewart, of Leeds, examined the sections of the tumour and formed the opinion that its histology closely resembled a primary papillary tumour of the kidney with intense foam-cell infiltration of the stroma. He agreed with Dr. F. B. Smith that in many ways it suggested a thyroid tumour without any evidence of colloid, resembling the Langhans Hürthle-cell tumour, but at that time the balance of the histological evidence was in favour of a renal neoplasm.

FIG. 35.—Photographs showing the appearance of the tumour.

Accordingly the renal tract was again investigated with a negative result and the skeleton was X-rayed, but no other focus of bone involvement could be detected.

PROGRESS.—The patient made a good recovery and not until June, 1949, was there definite evidence of a local recurrence in the region of the operation scar. About the beginning of that month an irregular thickened area began to appear, which rapidly increased in size until a very large mass occupied the right fronto-parietal region as shown in the accompanying photographs (*Fig.* 35).

The patient was still entirely free from symptoms and in fact was in excellent health. A further check of the central nervous system, cardiovascular, respiratory, and renal systems revealed no abnormality. The thyroid gland had undergone no change, there was still a small enlargement of the left lobe, which was firm on palpation and smooth, moving freely on deglutition, and gave rise to no symptoms whatsoever.

SECOND OPERATION.—In view of the rapid increase of the skull tumour it was decided to attempt a wide excision. This was carried out on July 11, 1949. A skin-flap was raised and the main projecting mass of the tumour removed by diathermy. The dura was found to be extensively involved and the very considerable opening into the skull had to be enlarged. Bleeding was excessive at the wide vascular base of the tumour and the patient suddenly collapsed and died.

POST-MORTEM EXAMINATION.—Dr. A. A. Miller, of the Pathological Department, carried out an autopsy and his findings were as follows :—

External Examination.—The body was that of a well-nourished female adult showing a large surgical scalp wound.

Internal Examination.—

Cranium : On reflecting the scalp there was a large area of eroded skull $6\frac{1}{2} \times 7$ cm., with irregular edges in the right fronto-parietal region (*Fig.* 36), through which a soft and vascular tumour was projecting. On removing the vault of the skull a large ' mushroom ' $8 \times 6\frac{1}{2} \times 1$ cm. thick was found to be attached to the dura by a slender stalk which passed through the dura into the cerebral cortex and the white matter of the posterior portions of the superior and middle frontal gyri and the anterior portion of the medial precentral gyrus. The tumour had a stalk into the brain, was irregular and nodular. It was composed of three or four fused nodules, the entire nodule being 4 cm. long, 3 cm. wide, and $2\frac{1}{2}$ cm. at the base. It projected for a distance of $2\frac{1}{2}$ cm. into a smooth-walled bilocular cavity (*Fig.* 37). The entire cavity in the cerebral substance was $4 \times 3 \times 2\frac{1}{2}$ cm. deep. The

tumour resembled a large mushroom with a thin stalk which penetrated dura and then expanded into a bulbous nodular root.

Thyroid: The left lobe of the thyroid was enlarged about the size of a hen's egg. The external surface was

FIG. 36.—Post-mortem appearance of the hole in the skull.

slightly nodular and was entirely smooth. On cross-section the structure was well circumscribed, solid, homogeneous, yellowish-pink, with scattered hæmorrhagic spots. Fibrous trabeculæ penetrated in various directions, dividing the tumour into lobules of different shapes

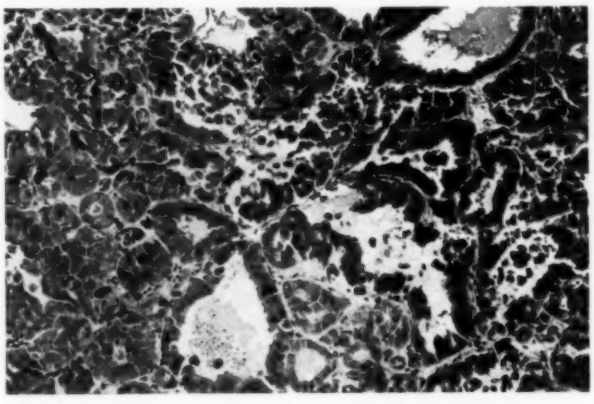

FIG. 38.—Thyroid gland. Large eosinophilic cells in acinar formation. (× 125.)

and sizes. There was one small fibrosed area near the centre of the tumour, also a few scattered calcified nodules. The right lobe was small and atrophied.

Histology: Histological examination of the thyroid tumour showed that it consisted of large eosinophilic finely granular cells arranged in single rows round the acini, which contained pink staining or dark red fluid (*Figs.* 38, 39). In many cases the cells were in solid trabeculæ. Near the periphery there were small clear rarefied areas with scanty acini resembling the thyroid. The staining reaction varied considerably in different parts of the tumour. One large area of the thyroid showed sheets of 'water-clear' cells of the 'hypernephromatoid' type of 'foam' cells, another section showed one or two small areas of similar cells. This structure of the thyroid tumour is clearly illustrated in the photomicrographs. The right lobe of the thyroid showed atrophic acini, most of which were empty. These features were reproduced in the metastasis in the skull (*Figs.* 40, 41).

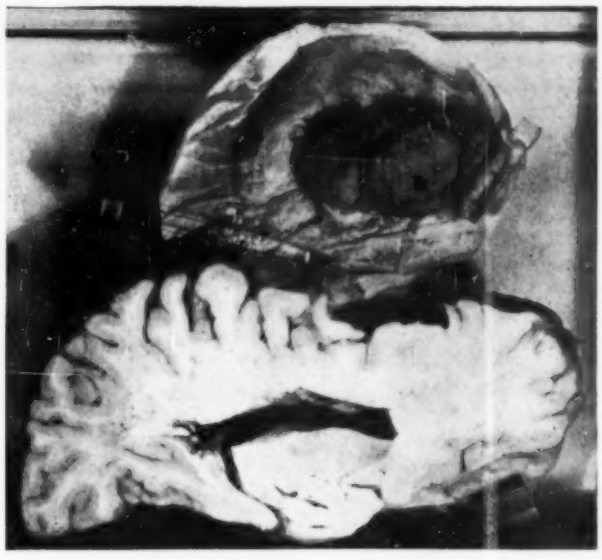

FIG. 37.—Dural flap showing cerebral downgrowth and cavity formed by the tumour in the brain.

Other Organs.—Both lungs were normal. The heart was normal except for a moderate amount of atheromatous degeneration in the main coronary blood-vessels. The liver showed scattered patches of fatty change, the spleen was soft in consistency but otherwise normal, kidneys

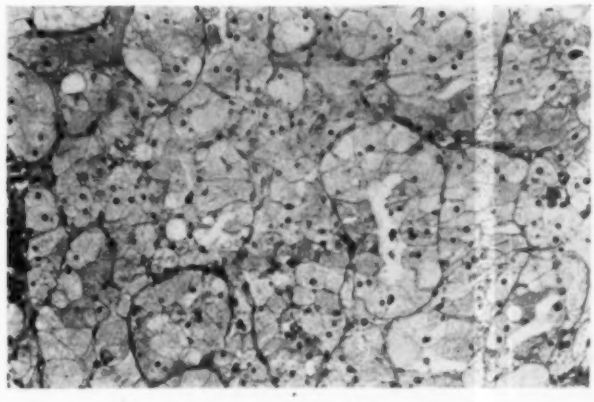

FIG. 39.—Thyroid gland. 'Water-clear' cells of the parastruma type in acinar formation. (× 125.)

and adrenals were normal, the bladder and the uterus were normal. One ovary was cystic and the other was small and atrophied. The pancreas showed autolytic changes only.

DISCUSSION

Pathological.—This case belongs to the Hürthle-cell group of metastasizing goitres and closely compares with the parastruma of Langhans. Both the water-clear cells of the foam or hypernephromatoid type and the large eosinophilic granular

cells were present in the left lobe of the thyroid, where no remains of the parathyroid structure could be found. The metastasis in the skull reproduced the histological structure of the thyroid tumour. The growth had invaded the scalp, skull, and the dura but the downgrowth into the cerebral tissue merely displaced the brain substance. It has been suggested that these so-called Hürthle-cell tumours originate from the para- or inter-follicular cells which were first described by Baber in 1874 and by Hürthle in 1894. The latter believed that there were two types of these cells: firstly, small cells round in shape; and, secondly, large cells which he thought coalesced to form the alveoli and which were considered to be similar to Baber's parenchyma cells. Recent views on the histology of the thyroid given by Maximow and Bloom (1945) have shown that these so-called interfollicular cells are probably tangentially cut pieces of the follicle walls, a view that would destroy any theory of the so-called Hürthle-cell tumour being derived from the presumed parafollicular cells.

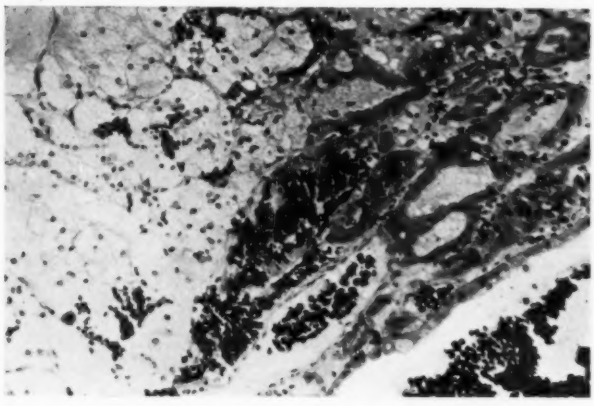

FIG. 40.—Scalp invaded by large eosinophilic cells and 'water-clear' cells arranged in acinar formation. (× 125.)

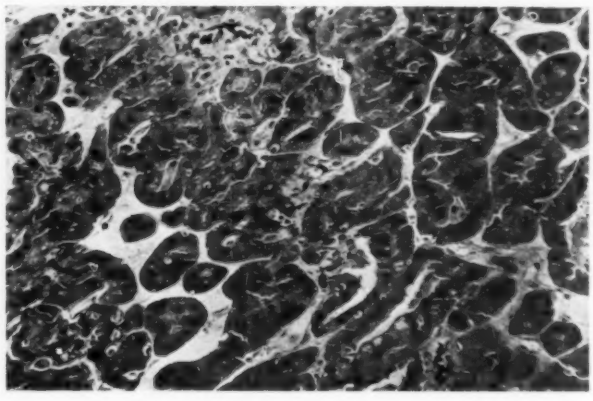

FIG. 41.—Dura mater invaded by large eosinophilic cells in acinar formation. (× 125.)

Willis, discussing the pathology of the Hürthle-cell tumours, points out that the name is a misnomer, because in the first place the eponym pertained to a cell first described by Baber, secondly the existence of the interfollicular cells was a matter of doubt, and thirdly there is nothing to link the histogenesis of these tumours and the so-called Hürthle cells. He makes it clear that these tumours contain the two types of cell so perfectly demonstrated in both the primary lesion and the metastasis in this case. He points out that some of these tumours show extensive areas of clear cell structure which he compares to the clear-cell renal adenocarcinoma, a comparison which he also draws between the water-clear cells of some parathyroid tumours and the clear-cell renal carcinomas. This comparison invites further inquiry into the relationship between the thyroid and parathyroid elements in these Hürthle-cell tumours. Willis attributes the origin of the tumour to the thyroid epithelium and he regards the lesion as a form of adenocarcinoma.

Ewing (1942) classifies these Hürthle-cell tumours as malignant and considers them to be small alveolar large-cell adenocarcinomas. In this he equates the tumour with Langhans' small alveolar atypical carcinoma which the latter ascribed to the cell groups that Getzowa (1907) regarded as remnants of the lateral thyroid anlage. In other words, Ewing considers that the Hürthle-cell tumour belongs to the group of metastasizing goitres which Langhans called 'struma post branchialis', and Ewing attributed the tumour to hypertrophic Hürthle cells of the thyroid alveoli. It has, however, already been pointed out that such cells may be portions of obliquely cut follicles. Joll (1932) also considered the presence of such cells as extremely doubtful.

Kraft (1929) described in great detail a most interesting case from the Metschnikow Hospital, Leningrad. A woman 60 years of age died from a metastasizing goitre which compared very closely with the Hürthle-cell tumours. The primary lesion was in the left lobe of the thyroid. This had produced secondaries in both lungs and pleura and in the left parietal lobe of the brain, which latter lesion had killed the patient. The striking feature of the pathology of the thyroid tumour was the presence of two distinct histological elements which also could be differentiated macroscopically. The bulk of the tumour was composed of masses of cells resembling in type the proliferative struma of Langhans, but in addition there were clearly defined areas recognizable with the naked eye, some in the centre of the tumour, others near the capsule. These consist of sheets of water-clear cells, polyhedral and columnar in shape, with a well-marked palisade arrangement next to the connective-tissue layer. These cells formed single alveoli and their structure closely resembled the water-clear cells of the parathyroid, a feature which was further emphasized by the palisading and the presence of fat-free vacuoles and 'red rose' cells.

A portion of the tumour described by Kraft may therefore be compared to Langhans' parastruma, whilst the other portions corresponded to Langhans' proliferative stroma.

Kocher (1899) was the first to describe this type of case in which the dominant role is played by the water-clear cells, and Kraft (1929) stresses the fact that in his case all the metastases consisted of water-clear cells combined with the great development of blood-vessels. In our case the water-clear cell formation both in the primary and secondary growth

is a most striking feature and suggests a close relationship with the tumour described by Kraft.

The histogenesis of the parastrumas enclosed in the tissues of the thyroid gland is derived by Langhans from foci of parathyroid cells embedded in the thyroid tissue and in the capsule of the gland. Such groups of cells have been described by Getzowa, and Michaud (1908), and in the case of cats and dogs by Kohn. Wegelin (1926) emphasizes the fact that foci of cells characteristic of the parathyroid may be present in tumours of thyroid origin. He found in the tissues of proliferative strumas transitional forms between the proliferative struma cells and the water-clear cells of parathyroid type. He regards of decisive importance the dominating cell of the tumour. If the main mass consists of water-clear cells he would consider the tumour to be of parathyroid origin, but if the picture was that of struma he would attribute it to the thyroid epithelium.

In Kraft's case both the macroscopic and microscopic findings indicate the parathyroid as a source of the tumour and the presence of water-clear cells in the secondary growths supported this theory. Moreover, the parathyroids on the affected side could not be found.

Symmers (1941) has described a so-called Hürthle-cell tumour which was resected from a baby six weeks old and had been present from birth. The tumour formed three masses representing the isthmus and the lateral lobes of the thyroid. The growth consisted of a connective-tissue capsule from which vascularized trabeculæ penetrated in various directions, dividing the tumour into lobules of different shapes and sizes made up of alveolar formation. Most of the alveoli consisted of a single layer of water-clear cells containing small, rather dense nuclei eccentrically placed. Symmers points out that this Hürthle-cell tumour of congenital origin contained intracellular fat-free vacuoles which are not met with in the normal thyroid or its neoplastic descendants, but its relationship to the fat-free vacuolated cells met with in the parathyroid is left an open question. This congenital tumour appeared histologically to be an adenoma, but Symmers could not deny the possibility of its malignancy. The photomicrographs of the tumour closely correspond to the foam or water-clear cells in our case, both those found in the thyroid and in the skull.

Eisenbergh and Wallerstein in 1932 recorded a case of Hürthle-cell tumour and formed the opinion that the so-called Hürthle cell is identical with the oxyphilic cell of Welsh, being one of the two types of cells composing the parenchyma of the parathyroid, and that these and the chief or principal cells were different stages of metabolic activity of the same cells, the former being the discharging stage and the latter the resting phase. In support of this view they cite the work and opinions of Erdheim in 1901 and Harnett in 1907.

This linkage of the parastruma type of metastasizing goitre with the parathyroid element suggests an explanation for the association between the metastases of this rare group of tumours and bone tissue, a predilection for secondary growth in a calcareous focus. Eisenberg and Wallerstein conclude that the tumour they examined originated from the parathyroid rests within the thyroid as described by Langhans and Getzowa, bearing a similar relationship to the thyroid as a hypernephroma to the renal tissue.

In the three cases reported by Martin and Elkin (1939) all showed a tumour composed of cells of the thyroid struma type but there was no evidence of the water-clear cell so characteristic of our case and those recorded by Symmers (1941) and by Kraft (1929), and therefore we are forced to the conclusion that there may be two elements responsible in some of these cases, one the thyroid and the other the parathyroid. In one instance the histological picture resembles the proliferating struma and in the other the parastruma. The water-clear cell areas appear to be the most active and it is noteworthy that they were absent in the case recorded by Hartgensen (1931) when the growth had been present for nineteen years, but in our case the change was fairly rapid, particularly the development of the intracranial metastasis after the initial operation.

Kraft stresses the point that the primary tumour of the thyroid may possess a complex structure, but the metastases in his case were everywhere the same, consisting of alveoli formed by the large water-clear cells, the whole surrounded by thin-walled capillaries. The great vascularity of the metastases was a marked feature of his case, and in our case the vascularity of the dural tumour was a most conspicuous feature. Clearly the picture is a composite one in which the proliferative struma and parastruma may be combined in the same growth and in its secondaries; or, on the other hand, the parathyroid element may be the outstanding histological feature, as in the congenital case recorded by Symmers—a view which is also supported by Wegelin's observation; or yet again, the struma of the small-alveolar large-cell type may be the dominant characteristic, in which case the growth is ascribed to the thyroid parenchyma.

Clinical Observations.—A perusal of the clinical history of these cases shows that a thyroid lesion may exist for many years before the primary tumour is removed by operation or death has occurred from the metastases. It is equally clear that the metastases show a tendency towards displacement of the host tissues rather than infiltration. This was strikingly demonstrated in our case by the displacement of the cerebral tissue from the downgrowing metastases from the dura, and in Kraft's case there was a similar displacement of brain tissue. Moreover, when local infiltration of the growth takes place, such as in the skull and the scalp, spread from the primary focus is comparatively slow relative to the enormous vascularity of the tumour, and equally remarkable is the absence of other secondary growths. It is also noteworthy that in our case and in others recorded by Kocher and Langhans, bone is the favourite site for the metastases. In the case described here there is no doubt that the secondary lesion first developed from a centre in the right fronto-parietal region. The absolute freedom of the patient from any sign or symptom which could be ascribed to a rise in intracranial pressure clearly proves that the skull was perforated from this primary metastasis before the growth spread over the dura mater or penetrated the latter into the brain tissue. This predilection for metastasizing goitre to produce secondary tumours in bone has already been noted.

Joll, in his Hunterian Lecture in 1923, collected a series of 44 cases where there were secondary deposits in bone showing the histological characteristics of thyroid tissue, whilst the thyroid presented the evidence of a simple goitre, and in some instances possibly of normal gland. Bell, in 1924, concluded that whilst there were great variations in the histological structure of the secondary deposits in the bone there was a striking tendency for all such deposits to reproduce the follicular structure of the thyroid gland. This tendency has fostered the idea of a benign metastatic type of thyroid tumour, but Bell has drawn attention to the destructive action of the thyroid deposits on the surrounding bone as a truer guide to their malignancy, a point which is strikingly demonstrated by our case ; the destruction of the skull despite the diathermy resection clearly emphasizes the local virulence of this growth which on the other hand appeared to be absent in all other parts of the body despite an enormous blood-supply surrounding the developing tumour.

Clinically there is a striking difference between metastasizing goitres and true cancers of the thyroid. In the former the primary lesion of the thyroid is generally inconspicuous and gives rise to no symptoms, whereas the secondary tumour, often in bone, is the first lesion detected and in some cases the only one the patient or clinician is aware of ; moreover, many of these patients remain in good health until gross secondary pressure symptoms develop from a distant metastasis. On the other hand, carcinoma of the thyroid gives striking proof of the local development of the primary tumour and also of the regional secondary nodes, together with evidence of malignant cachexia. In a few cases parastruma of the so-called Hürthle-cell type may be associated with a thyrotoxic syndrome.

Treatment.—From the point of view of treatment, resection of the primary thyroid tumour in the case of metastasizing goitres is clearly indicated. This emphasizes the importance of an early biopsy in the case of obscure neoplasms arising in the skull and other bones, and the exploration of the thyroid, no matter how small the gland would appear to be, if there is evidence of struma or parastruma metastasizing to the bone tissue. Failure to do so in the case recorded here was partly due to the overshadowing clinical emergency of the skull lesion, especially from the patient's standpoint, and, on the other hand, the association of the tissue removed at the first operation with a renal tumour as its source of origin. It is suggested that if the primary tumour is removed a secondary growth of the type described in this case might have been more satisfactorily attacked by radiotherapy. Operative interference appeared to accelerate the local invasive action of the metastasis into scalp, skull, dura, and cranial cavity.

CONCLUSIONS

1. Metastasizing goitre of the so-called Hürthle-cell type is a condition of great rarity and corresponds to the struma post branchialis of Langhans and Getzowa and the parastruma of Langhans.

2. The principal histological elements in these tumours are the water-clear cells and the finely granular large eosinophilic cells.

3. According to some, these cells represent two phases of activity of the same epithelium, being the resting and the secreting phases.

4. Some regard these elements as evidence of parathyroid origin, particularly if the water-clear cells predominate. On the other hand, if the granular oxyphilic cells are mostly in evidence, the tumour is considered to be of thyroid origin. There appear to be two distinct elements present in these tumours.

5. If the thyroid element predominates it is suggested that the thyroid alveolar structure seen in the metastases of the so-called benign metastasizing goitres may be due to the slower development of the proliferative struma type tumour, whereas in the cases where the water-clear cells are an outstanding histological feature the tumour is rapidly developing and does not approximate to the normal thyroid, being more closely linked to the parathyroid.

6. There is a distinct difference between the clinical course of these rare tumours classified as atypical carcinomas and the malignant tumours belonging to the well-recognized histological types. The latter tend to disseminate in over 70 per cent of the cases to the regional nodes in the neck, whereas the former usually metastasize to bone and especially to the skull, the regional nodes being involved in only a few cases. Some of these cases show a mild degree of thyrotoxic symptoms, but these changes are not associated with either the water-clear cells or those of the proliferative struma type : they appear to arise from independent thyrotoxic changes in other portions of the thyroid gland.

7. The clinical course of the metastasizing struma-parastruma (Hürthle-cell tumour) is singularly inoffensive until pressure symptoms arise, commonly from a remote secondary growth. The primary lesion of the thyroid develops very slowly and produces negligible clinical effects.

8. Thyroidectomy for the primary tumour and radiotherapy for the secondary metastases would appear to be the most appropriate method of treatment.

In conclusion, I must express my sincere acknowledgements to Dr. A. A. Miller for his interest and help in the pathological aspects of this case and for his report on the autopsy and the photomicrographs ; also to Dr. R. B. Wilson, to whom I am indebted for a complete translation of Dr. Kraft's paper ; and to Dr. F. B. Smith, Professor Matthew Stewart, and Dr. R. A. Willis for their helpful comments on the pathology of this growth. To Mr. Arthur Robinson we are indebted for the photographs of the patient and of the specimens.

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THE BONE-BANK IN NEUROSURGERY*

BY HAROLD ELLIOTT AND H. J. SCOTT

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SINCE 1898, when one of the earliest of neurosurgeons, Sir William Macewen of Glasgow, introduced bone-grafts (as far as English literature is concerned) into modern surgery, bone defects have been filled by various materials in an unrelenting search for more perfect methods of anatomical restoration.

Preservation of bone by modern deep-freezing and the establishment of a so-called 'bone-bank' has suggested this method as a natural means of filling in cranial defects. Such a recommendation implies that a kitchen-type, deep-freeze, refrigerator unit should become an additional piece of equipment in any neurosurgical operating unit.

This method was used successfully in the case described. In addition, it might be added that our patient was much more content knowing that he had "his own bone" instead of a metal plate filling in the cranial defect. The place of this procedure in the treatment of acute compound fractures of the skull so commonly seen in war time, as well as in the (traumatic) neurosurgical services of busy city hospitals, may be worthy of trial.

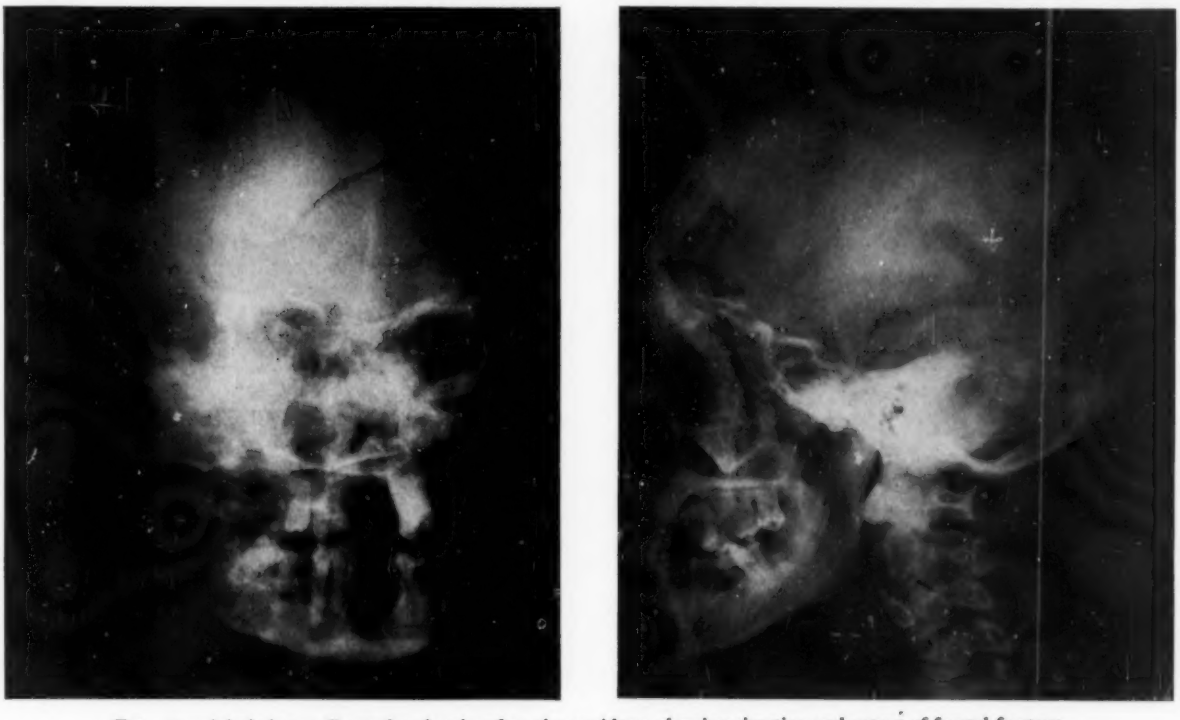

FIG. 42.—Admission radiographs shortly after the accident, showing situation and extent of frontal fracture.

CASE REPORT

Compound fracture of the skull, right frontal; cerebrospinal rhinorrhœa; radical débridement with closure of dural lacerations; preservation of removed bone; primary healing of scalp wounds; development of pneumocephalus; re-operation;

* Presented to the Montreal Medical Chirurgical Society, October, 1948.

closure of fistula; replacement boiled bone fragments after ten weeks' refrigeration; primary healing; post-operative course satisfactory after eighteen months' follow-up.

On July 2, 1948, J. W. S., a steward on an ocean-going vessel, was injured in an automobile accident after a drinking party, and suffered a compound fracture of

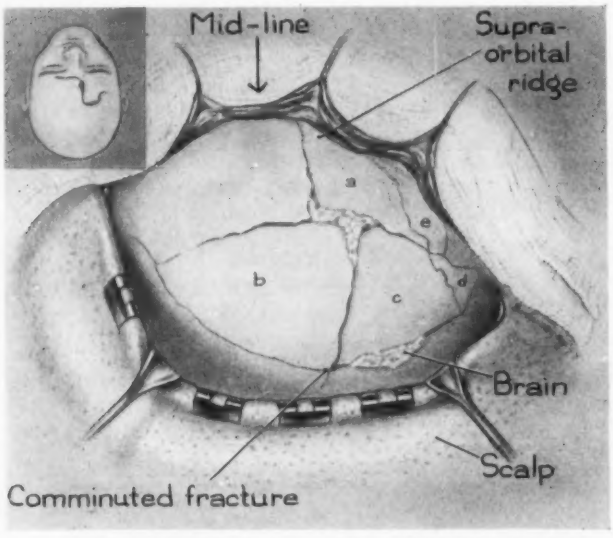

FIG. 43.—To show the site of right orbito-frontal damage and the type of operative exposure.

the skull. On arrival at hospital he was semi-conscious with two forehead lacerations and through these wounds softened brain oozed. Radiographs (*Fig.* 42) showed numerous radiating fractures into the ethmoid and frontal sinuses. There was an obvious spinal fluid rhinorrhœa.

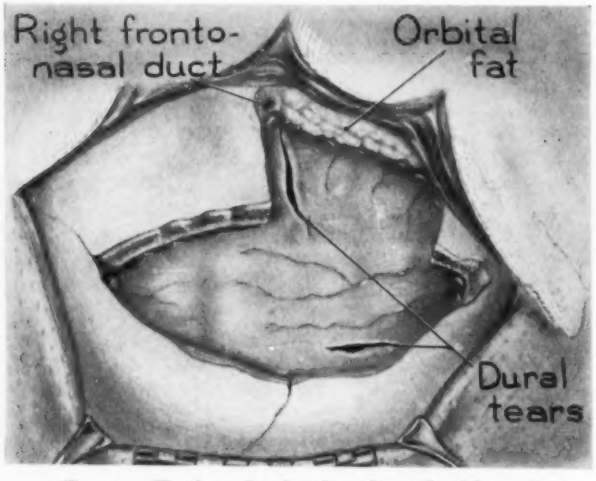

FIG. 44.—To show the situation of two dural lacerations. Another laceration of the dura farther back along the cribriform plate was missed.

Spinal fluid lumbar punctures showed subnormal pressure with numerous red blood-cells. Vision in the right eye seemed intact, but was absent in the left eye.

In order to excise the scalp wound and obtain satisfactory exposure, a Z-shaped incision was used (*Fig.* 43). The fracture lines extended into the orbit and in order clearly to see the underlying damage, these fragments were removed. They were immediately put in an autoclaved glass jar with a screw top, labelled with the patient's name and date, and sent to the deep-freeze unit in the 'blood bank' of the Department of Pathology. We were not quite prepared for storing the bone, but took the initiative and preserved the bone as outlined. Because of the innovations we boiled the bone before replacing it. (The deep-freeze unit operates at temperatures from -20° C. to -40° C. and averaged a temperature of -25° C. for the twelve weeks' interval before the frozen bone was replaced into the skull defect.)

There were two main dural lacerations directly underneath the scalp lacerations (*Fig.* 44). There was also visible contusion of the under-surface of the frontal lobe. The scalp lacerations were freshened, the softened brain was removed, the dural lacerations were closed, and this closure was reinforced with pericranium. The patch of pericranium was further reinforced with gelfoam. Gelfoam was also inserted into the nasofrontal duct. The roof of the orbit was removed and the orbital fascia used further to obliterate the unfilled space. Primary healing of the wound was obtained. (In retrospect an intradural exploration would have disclosed an additional dural tear

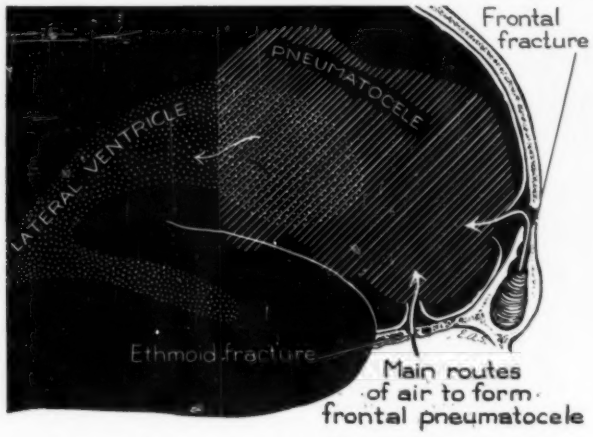

FIG. 45.—Main routes of air to form frontal pneumatocele.

over the cribriform plate, and water-tight closure of this tear might have prevented the cerebrospinal fluid leak that developed.)

Serious rhinorrhœa persisted for three post-operative days. In addition there was urinary incontinence and mild pyrexia during the first ten days. After the first week the spinal fluid leak appeared to stop, then could not be demonstrated on posture, although the patient was noticed to 'sniff' more than usual. Then the patient seemed to settle down, and a good result was hoped for. When the patient returned to hospital after ten weeks, he appeared confused. A smooth, tense swelling was felt in the centre of the skull defect, and skull films showed a large pneumocephalus (*Figs.* 45, 46). Even on bending forward and touching his toes a cerebrospinal leak (rhinorrhœa) was not demonstrated. (*Fig.* 47.)

At re-operation (August, 1948) a fistula was disclosed below and behind the site of the subfrontal, pericranial patch. From the previous operation the gelfoam was still present. Fascia lata from the right leg was used to close this secondary fistula and interrupted silk sutures were used to bring the edges together (*Fig.* 48).

The fascia lata was doubled over in order to provide an additional barrier between the orifice of the fronto-nasal duct and the subdural space. This again was covered with gelfoam.* Then the bone fragments (which had been boiled as an added precaution) were reinserted and fixed to the skull defect with rustless steel wire (*Fig.* 49).

* In the Canadian Neurological Hospital overseas (R.C.A.M.C.) Lt.-Col. Botterell originated this technique and it was called 'the sandwich'.

The wound was closed and primary healing was obtained.

The second post-operative course was more satisfactory and he was discharged from hospital in three weeks. He continued to improve and mentally he was much more alert.

He was sent home to Liverpool by boat, where he has been followed by Mr. Sutcliffe Kerr. On Oct. 26, 1948, a report states: "He has been completely free from his headaches and there has been no suggestion of epilepsy. Cosmetically the skull defect has been repaired very well. The scar is a little unsightly but is not of a very serious handicap to a man. His most serious disability is the loss of vision in the left eye. To-day his visual acuity was ability to count fingers at one foot with the left eye. Visual acuity is normal in the right eye and so is the visual field. By the ophthalmoscope a scar can be seen running across the left macular region of the retina and there is marked optic atrophy. The right fundus is normal. The left pupil is dilated and almost inactive to light, but reacts well consensually. The left palpable fissure is wider than the right, probably due to slight scarring.

"The patient claimed to be able to smell normally but was unable to smell five or six test odours. The remainder of the central nervous system is completely normal. The patient is very anxious to be allowed to return to sea again."

The patient was again seen by Mr. Kerr in April, 1949, who reported as follows: "He has had no headaches and no fits. His only disability is very poor vision in the left eye, but the vision and the visual field are

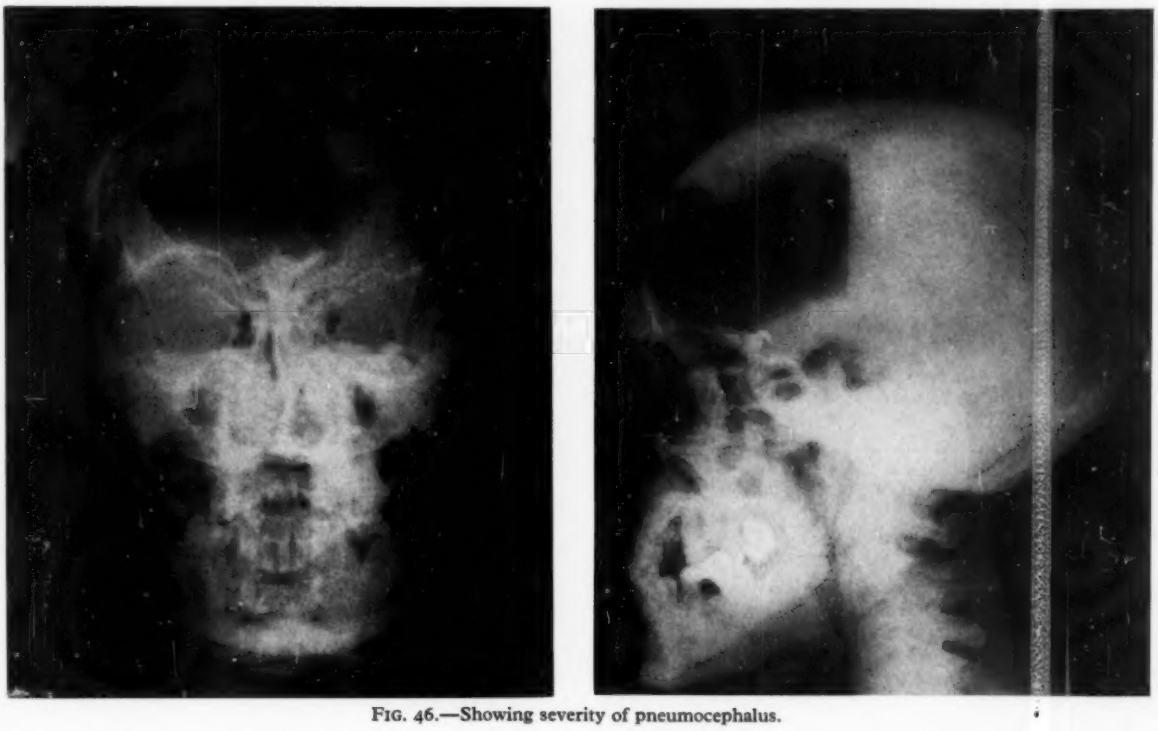

FIG. 46.—Showing severity of pneumocephalus.

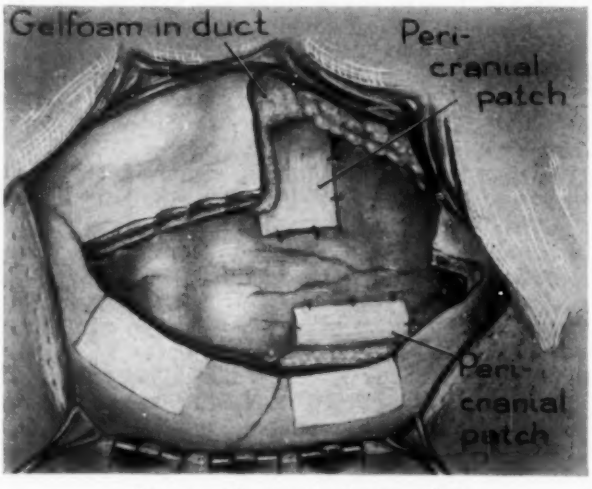

FIG. 47.—Closure after first operation.

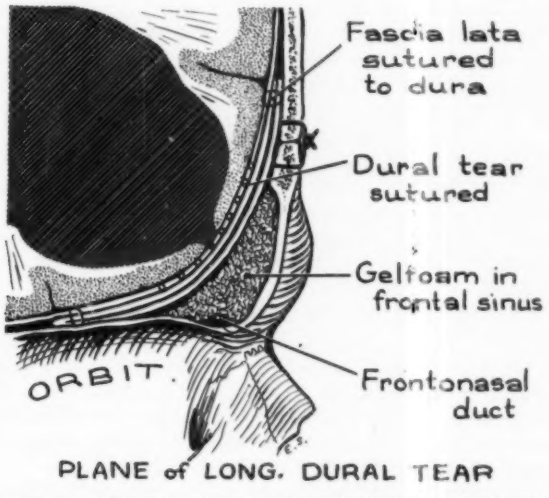

FIG. 48.—Reconstruction of closure of spinal fluid fistula and replacement of deep-frozen bone.

normal in the right eye. I consider this patient is now fit for return to full duty."

DISCUSSION

The usual neurosurgical technique for compound head wounds has been to carry out a satisfactory débridement of scalp, skull, dura, and brain. Unfortunately, this method results in cranial defects of varying size. Perhaps less radical bony removals with the help of the antibiotics may be practised in the future than that recommended in the past. In our experience conservative removal may result in delayed post-operative infection, with osteomyelitis appearing as late as one year after the first operation.

On the other hand, Botterell, Stewart, and Elliott* showed in an unpublished manuscript that primary healing could be obtained in infected head wounds if radical débridement and liberal use of the antibiotics was employed. In these cases primary tantalum cranioplasty was also carried out with success.

Some method whereby cranial defects can be repaired easily, safely, and cosmetically is greatly needed. Various materials (silver, celluloid, tantalum, acrylic resin, other plastics, os purum, rib, iliac bone, etc.) have been used. All these materials have disadvantages, though tantalum was probably the most popular material in World War II.

This is especially true in the case of orbital defects where radical removals are required and cosmetic requirements are demanding. White (1948) has reported late complications following frontal alloplastic plates. In a large number of cases, the Canadian Army experience seemed to indicate that tantalum or acrylic resin gave the safest satisfactory results. From the experience with this case, preservation of the patient's own orbital margin in the deep-freeze unit and later replacing it seemed very satisfactory.

Inclon (1942) reported on the use of homologous preserved bone-grafts which had been preserved in temperatures of 37° F. to 40° F. for three weeks and found it useful in children or so-called 'poor risk' cases. Bush (1947) published his experiences with bone preserved at − 20° C. to − 5° C. and stated that bone could be kept indefinitely at − 25° C. Homografts from the 'bone-bank' had been used by this author in 67 operations with only 4 complications. Microscopical studies of bone removed from fused cases in which homogeneous bone had been used showed the grafts to be 'dead', but surrounded by connective tissue undergoing metaplastic and new-bone formation. There is thus eight years of experience in the use of bone-banks and it seems safe now to advocate a trial in the treatment of compound head wounds.

FIG. 49.—To show replacement of bone after twelve weeks in deep-freeze unit.

SUMMARY

A brief review of 'bone-banks' is presented. A method of preserving the patient's own bony fragments in a well-labelled glass jar is presented. This bone can be frozen and preserved for many weeks and then used to fill in the bony gap. This may have numerous applications in the neurosurgery of head injuries in war and peace.

* Presented to the British Society of Neurological Surgeons, November, 1945.

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ENDO-ANEURYSMORRHAPHY

A REPORT OF THREE CASES OF NON-TRAUMATIC ANEURYSM SO TREATED

By LAMBERT ROGERS, Cardiff

Resection is usually regarded as the procedure of choice for the treatment of aneurysms, and in this country to-day few surgeons are in favour of opening directly into them.

In the three cases here recorded, however, the indications for aneurysmorrhaphy appeared to be precise and the results were satisfactory. A further reason for recording one (possibly two) of these is that until recently few successful operations have been performed for mycotic aneurysm, and until the introduction of effective antibiotic drugs for the treatment of the endocarditis in these cases, any surgical effort was almost always futile.

It will be recalled that the operation of aneurysmorrhaphy was first described in 1888 by Rudolph Matas, of New Orleans, whom some of us had the pleasure of meeting there in October, 1949, and that it came about as a result of that necessity which is so often the mother of invention. Dr. Matas had performed ligation of the main artery proximally (Anel's operation) and later distally for a large traumatic aneurysm extending from the axilla to the elbow of a young negro. The aneurysm had recurred and he had set out to resect it, but found that the brachial plexus was so intimately adherent to the sac that resection would not have been possible without considerably damaging the plexus or the large nerves coming from it. He therefore boldly opened into the sac and closed by sutures those openings into it which were feeding it and had caused its recurrence. The result was highly successful. Various modifications of the operation were later elaborated by Dr. Matas as obliterative, restorative, and reconstructive forms of endo-aneurysmorrhaphy.

This direct attack on the aneurysmal sac was not new. The treatment of aneurysms had bulked largely in surgical practice in pre-Listerian times, and an old operation of laying open the sac and securing the ends of the vessels used to be performed and was often successful. The records of some of these operations are among the surgical classics; Mr. Alexander Miles, of Edinburgh (1918), has graphically related how James Syme, assisted by Lister, performed a successful operation of this type on a left axillary aneurysm and had similar successes in cases of carotid and gluteal aneurysms. The Matas operation, however, differs from this old operation of Antyllus, which consisted in ligating the main artery as it entered and left the sac, the contents of which were evacuated, in that in the Matas operation the main artery is controlled on the cardiac side but neither tied here nor distally and the openings into the sac are closed by sutures.

With the present successful treatment of infective endocarditis by chemotherapy it may be that the surgical treatment of aneurysms will be called for more often.

CASE REPORTS

Case 1.—**Aneurysmorrhaphy for false aneurysm of the profunda femoris.**

A retired night watchman, aged 65, who had had several attacks of rheumatic fever earlier in life and for the past five years had suffered from precordial pain and breathlessness on exertion, developed pain in his left groin and thigh, collapsed in the street, and was brought into a medical ward of the Cardiff Royal Infirmary under the care of Dr. William Phillips. He was found to be suffering from mitral and aortic disease and to have a large pulsatile swelling in the inner aspect of his left thigh which he stated had only appeared after he collapsed in the street. Three weeks after admission, as the tumour was increasing in size, he was anæsthetized with nitrous oxide and oxygen, the external iliac artery exposed and controlled by a piece of tape passed around it and the swelling incised. It was found to be a false sac containing a large amount of clot which, when evacuated, revealed the vessel involved to be the profunda femoris. The openings into the sac were secured and its redundant part infolded. He was given a blood transfusion, the limb was kept cool and at rest, and the body warmed. He made a good recovery and the circulation of the leg did not at any time appear to be in jeopardy. A year later he developed cardiac failure, from which he died.

The next case recalls the old difficulty of distinguishing between abscess and aneurysm, which was so often referred to by nineteenth-century writers on surgery. The following quotation is from the valedictory address of Oliver Wendell Holmes, delivered on March 10, 1858, at Harvard :—

"... Mr. Dease, of Dublin, was more fortunate in a case which he boldly declared an abscess, while others thought it an aneurism. He thrust a lancet into it, and proved himself in the right. Soon after, he made another similar diagnosis. He thrust in his lancet as before and out gushed the patient's blood and his life with it. The next morning Mr. Dease was found dead and floating in his own blood. He had divided the femoral artery."

Case 2. — **Aneurysmorrhaphy for popliteal aneurysm which had been incised in mistake for an abscess.**

For four weeks a collier, aged 58, had felt pain which he regarded as rheumatism, in the back of his right knee. He worked for a week but the pain became much worse and he was seen by his doctor, who sent him to a local hospital. He was there told that he had an abscess and two days later an incision was made into it. A little dark blood escaped but the pain persisted and whenever he coughed there was a small trickle of blood from the wound. Four days after operation a sinus forceps was inserted into the wound and again a little blood escaped. The next day there was a more profuse hæmorrhage which began spontaneously and which the surgeon arrested with some through-and-through sutures. It was now realized that the patient had a popliteal aneurysm and he was transferred to the Cardiff Royal Infirmary. On admission he was found to have a swelling in the right popliteal fossa over which an incision had been made and closed with sutures between which blood was oozing.

The wound edges were reddened and apparently infected. Because of the infected wound, excision of this appeared to be indicated and a direct attack was therefore made on the aneurysmal sac, the femoral artery being compressed by an assistant while the wound track was excised and the clot turned out of the sac. The openings in the sac were then sutured, and its redundant part cut away. A corrugated rubber drain was left in the wound and penicillin therapy instituted. This drain was removed 48 hours later and the limb was treated as in the previous case, by cooling and at rest, the body being heated to relax the peripheral arterioles.

FIG. 50.—*Case* 3. Upper incisions for lumbar ganglionectomy and division between ligatures of the external iliac artery; lower incision for aneurysmorrhaphy.

He made a good recovery and now, over two years later, is working from 7.30 a.m. to 5.30 p.m. as a storekeeper. He walks a mile with ease. There is slight œdema of the foot and ankle, which appears during the latter part of the day and disappears on recumbency.

Case 3.—**Division of external iliac artery followed later by aneurysmorrhaphy for mycotic femoral aneurysm.**

A Polish labourer, aged 23, was admitted to the Medical Unit of the Cardiff Royal Infirmary under Professor A. M. Kennedy, where a diagnosis of infective endocarditis was made. While under treatment a left femoral aneurysm appeared beneath and below Poupart's ligament and gradually enlarged downwards so that it appeared to involve the common, superficial, and deep femoral arteries. As it was steadily increasing in size, a lumbar sympathectomy was performed and the left external iliac artery divided between ligatures. Following this (Hunterian) operation there was much reduction in the size of the aneurysm and its pulsation became almost imperceptible, but wasting and weakness of the left quadriceps muscle was noticed and so, some ten weeks later, the sac was explored. As the femoral nerve was found to be intimately adherent to the wall of the aneurysm, the sac was opened and an obliterative aneurysmorrhaphy carried out. The limb was subsequently kept cool and at rest, while the body was heated. He made a steadily progressive recovery and fifteen months later is well and free from symptoms. (*Fig.* 50.)

COMMENT

Following the recent war, a remarkable series of cases of traumatic aneurysm which had been treated highly successfully, either by aneurysmorrhaphy or resection, was published by D. C. Elkin, of West Virginia (1946). Records in which the operation of aneurysmorrhaphy has been performed for cases occurring in civilian practice and not due to injury are, however, apparently few. In those here reported there were precise indications for aneurysmorrhaphy and it appeared that other methods of treatment were less desirable or less likely to be effective. The fact that in certainly one and possibly two of these cases the aneurysm was of the mycotic type is perhaps noteworthy, since such cases have only recently, following the successful treatment of infective endocarditis by chemotherapy, entered the realm of feasible surgical practice.

SUMMARY

Three cases of aneurysm (two femoral, one popliteal) are recorded, for which aneurysmorrhaphy appeared to be the procedure of choice. Following operation in each case the peripheral circulation of the limb was adequate.

Endo-aneurysmorrhaphy is a useful procedure in cases of mycotic aneurysm for which successful treatment by surgery may more often be expected now that bacterial endocarditis can be controlled by appropriate chemotherapy.

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CONGENITAL ABSENCE OF THE GALL-BLADDER: CHOLANGIOGRAPHY: GALL-STONE SOLVENTS

By A. J. H. RAINS, Birmingham

This report is on a patient whose operation for obstruction of the common bile-duct revealed congenital absence of the gall-bladder and on whom cholangiography was subsequently performed in order to demonstrate this absence, and at the same time proving free passage of bile into the duodenum. An abnormality of the lesser omentum was also noted. Ether was used as a gall-stone solvent.

The purpose of this paper is not only to record this case, but to try to bring together the experience of other writers in each one of the features mentioned above.

CASE REPORT

Mrs. C., aged 61, was admitted to hospital on Aug. 20, 1949, with a provisional diagnosis of acute cholecystitis. She gave a history of infrequent attacks of right subcostal pain occurring every few months for the past fourteen years, but the attacks had recently become worse

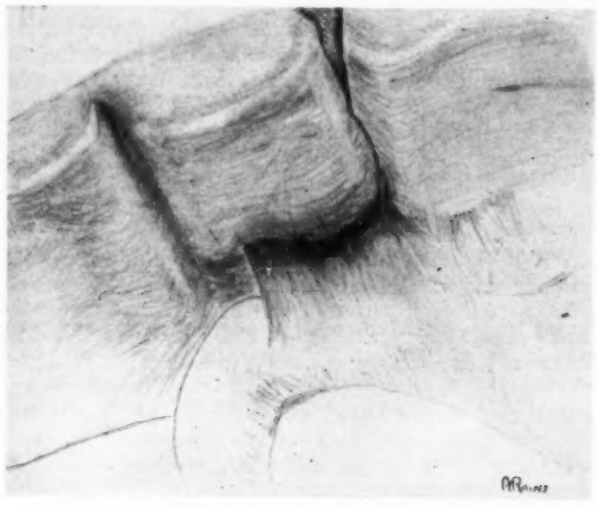

Fig. 51.—Showing the well-marked quadrate lobe, the absent gall-bladder, and the extension to the right over the duodenum of the lesser omentum.

and more frequent, so that she was getting them every few weeks, and in addition was retching and vomiting. She had had a severe attack 2½ years previously, and was then advised to have her gall-bladder removed, but this she refused, and she had been on a low-fat diet ever since. On the present occasion the patient's condition very soon improved and a cholecystogram was performed on Sept. 6, but as no gall-bladder shadow could be obtained, the investigation was repeated three days later, with the same result. It was decided to remove the gall-bladder in the interval between attacks. She was sent to a convalescent home to await the operation, but she was back again in hospital on Sept. 26, as she had had three attacks of pain, the last being very severe, and followed by jaundice. Her urine had become dark and her stools pale. She was very tender in the right subcostal region, and it was apparent that she was suffering from obstruction of the common bile-duct. Her temperature swung 3° for two or three days, and then she became apyrexial and the urine and fæces returned to normal colour.

On Nov. 2 a laparotomy was performed under a general anæsthetic, and through a subcostal incision a normal-sized liver was found, but with well-marked fissures and a large quadrate lobe. There was no sign of

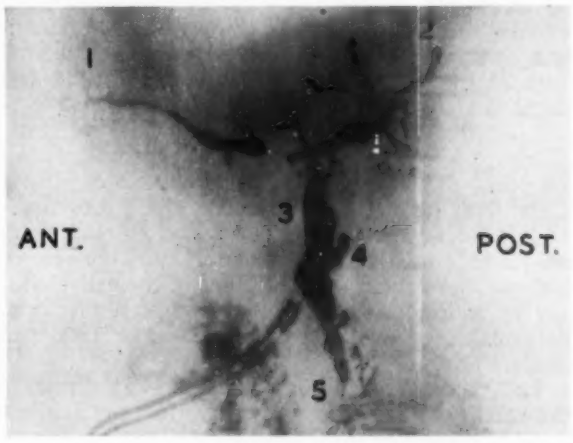

Fig. 52.—An obliquely taken film showing, from behind: (1) Part of the left hepatic duct extending forwards and to the left; (2) The right hepatic ducts; (3) The dilated common duct; (4) The cystic duct and absence of the gall-bladder; and (5) The sphincter of Oddi and showing the passage of lipiodol into the duodenum.

the gall-bladder, its fossa being represented by a deep fissure; and a membrane extended from the antero-superior aspect of the first part of the duodenum to the porta hepatis. This membrane was a well-defined structure, and although it had a free margin to the right, it appeared to be continuous with the lesser omentum on the left. The common duct and portal vein were behind it, but not within its free margin (*Fig.* 51). This membrane was divided and revealed an enormously dilated common duct as big as my thumb. Many calculi could be felt in it, and when opened, eight mixed calculi were removed from the hepatic ducts above, and two smaller ones from the common duct below. There was a great deal of biliary sludge. A sound was passed through the duct into the duodenum and the opening appeared to be satisfactory. Two drainage-tubes were passed into the duct, both of them upwards, into the right and left hepatic ducts respectively. A further search still revealed no evidence of a gall-bladder..

The patient recovered satisfactorily and biliary drainage was between 18 and 22 oz. in every 24 hours. Vitamin K was given daily. On Nov. 10 (the eighth post-operative day) a cholangiogram was performed and this showed no gall-bladder shadow but suggested the presence of the cystic duct. The common bile-duct and hepatic ducts were outlined and some lipiodol was seen in the duodenum and jejunum (*Fig.* 52). Every day for the next five days 1 c.c. of ether was injected into each tube after irrigation with saline, and the tubes were left open after injection. About one hour later 5 c.c. of olive oil were instilled, and during the succeeding hours an increased amount of sludge and debris appeared from the drainage-tubes. A second cholangiogram was performed on Nov. 15 and the hepatic ducts were even

better outlined. The tubes were then removed and the wound soon healed.

Since returning home she has had one attack of pain, without jaundice, in January, but since then she has been extremely well. She tells me that she can eat anything now and has no pain, but she has a weakness in the part of the wound where the drainage-tubes lay.

DISCUSSION

On the Absent Gall-bladder.—In development, the biliary tract, which includes the liver, arises as a ventral outgrowth of gut-endoderm from the future duodenum. At first tubular, the outgrowth consists of one portion which will become the liver and bile-duct, and another which will become the gall-bladder. This tubular structure soon changes into a solid one and is re-established in its final tubular form later. Failure of the biliary outgrowth to form, or of its lumen to become re-established after the solid phase, will result in a deformity of the tract, as also will aberrant growth of one part. Thus it is possible to encounter absence of the liver or a greatly enlarged lobe; absence of the bile-duct or an atretic one; and absence of the gall-bladder or a multilobed one. Writers referred to also quote a theory that absence of the gall-bladder may be acquired—for instance from syphilis, catarrhal inflammation of the biliary tract, or fœtal peritonitis.

In 1890 Courvoisier described 25 cases of abnormality of the biliary tract and in 1947 Latimer, Mendez, and Hage reviewed the reports on 71 patients exhibiting congenital absence of the gall-bladder and discussed the incidence (0·07 per cent), the aetiology, and the variety of locally associated congenital and acquired conditions of the biliary tract, such as variation of the liver lobes and dilatation of the common-duct, with or without stones. Of the 71 cases reviewed, 34 of the reports were on the living, and the rest at autopsy. The ratio of male to female over all cases was 1 : 1. The average age when discovered was 46 years. Of the 34 living patients the abdomen was opened for obstruction of the common duct in 8 cases. Although the gall-bladder was absent in all 34 cases the cystic duct was absent only 15 times. In 21 of the reports available to these workers the common duct was dilated in 11 patients and stones were present in 11. In 13 reports concerning varieties in liver anatomy, atrophic and hypertrophic livers, a large Reidel's lobe, absence of the left lobe, and absence of the quadrate lobe, were all described. My patient possessed a well-marked quadrate lobe.

At operation in this case it will be noted that a membrane was seen running from the anterosuperior surface of the duodenum to the underside of the quadrate lobe and porta hepatis, which I presumed to be an abnormality of the lesser omentum. As described, this membrane did not appear to be of an inflammatory nature, for it possessed a distinct right lateral margin, and to the left appeared to be fused with the lesser omentum. There was no evidence of duodenal ulcer. The presence of such a membrane was stressed in a paper by Waugh (1919) on the morbid consequences of a mobile ascending colon. The membrane he described also ran from the duodenum to the under aspect of the gall-bladder and cystic duct, and extended to the gastro-hepatic omentum on the left. Waugh suggested that it is most likely due to the persistence of a small portion of the primitive anterior mesogastrium, between the layers of which the gall-bladder develops, rather than to adhesions of inflammatory origin which would, in all probability, show a more haphazard formation. In a review of 60 patients with congenital absence of the gall-bladder, Villareal (1948) describes exactly the same feature in one of his cases.

On Cholangiography.—Cholangiography was used in 1932 by Mirizzi, whilst Hart Hagan and Townsend (1948) discussed the value of immediate and delayed cholangiography. An immediate cholangiogram at the time of operation has its technical difficulties, but may be of use to demonstrate the free passage of the material used through the common bile-duct into the duodenum and the presence of an undetected stone in the duct. In the case of a biliary fistula or common duct drainage, a delayed (post-operative) cholangiogram will show an undetected stone or stricture, and is also of use in demonstrating the return of the dilated common duct to normal size. This method will also show any anomalies of the biliary tract. The injection material used by these writers was 35 per cent diodrast, since they thought that iodized oil was unsatisfactory. Best (1938) felt that oil had a beneficial effect in that it appears to ease the patient and relax the sphincter of Oddi. On the two occasions that I used iodized oil for cholangiography no untoward effects were encountered. Injection was made slowly, taking an exposure after 5, 10, and 15 c.c. had been injected. It is, of course, necessary to stop the investigation completely should pain be felt in the upper abdomen or back. Anteroposterior films were taken, but I was able to demonstrate the left hepatic duct more clearly on a left lateral film. The cholangiogram in my patient served to show that no gall-bladder existed, even an intrahepatic one, but did demonstrate what was probably a cystic duct. It also showed the state of the cystic duct, the common bile-duct, the patency of the sphincter of Oddi, and the absence of any stone that might have been undetected at the time of operation. Smyth (1949), reporting on a patient with absence of the gall-bladder and using cholangiography, demonstrated well the spasm of the sphincter of Oddi which follows injection of morphine.

On Gall-stone Solvents.—A gall-stone solvent (ether) was used on this patient because it was not certain that the hepatic or common bile-ducts had been completely cleared. This uncertainty arose from the observation that most of the stones removed were situated in the upper part of the common duct and the two main hepatic ducts. The first cholangiogram failed to demonstrate the left hepatic duct clearly, and this might have been due to a remaining stone. The second cholangiogram (after using ether) showed the left hepatic duct quite well. The attack of pain which the patient suffered two months after operation might indicate that even after using the solvent, a stone or some sludge was passed.

Ether was successfully used by Walker (1891) for dissolving a residual stone causing symptoms following cholecystectomy. As ether vaporizes rapidly (1 c.c. of ether becomes over 200 c.c. of vapour at body temperature) he pointed out that it was important to allow the vapour to escape after injection.

Pibram (1935) described the use of ether for dissolving stones in the common duct which he could not remove by the trans- or retro-duodenal route on account of the patient's poor condition. He also used it in patients in whom there was the least suspicion that all the stones had not been removed. Ether will dissolve a stone even if it is embedded in the wall of the common duct, and he suggested that the method might be applied to the treatment of biliary fistula caused by stones in the common duct which were overlooked at operation, by introducing a tube down the fistula, instilling the ether, and causing a softening and partial dissolution of the stone, thereby avoiding a second complicated operation. Cholangiography was also used by him to demonstrate the patency of the common duct. When using ether he injected no more than 3 c.c. daily, and also stressed the importance of leaving the tube open after injection, for if it is not left open the pressure effect on the liver might have unpleasant consequences.

Best (1938), in a paper on cholangiographic demonstration of the overlooked common duct stone and its non-operative management, did not use ether but antispasmodics such as nitroglycerin and atropine followed by instillation of olive oil into the common bile-duct, and this he found very effective and soothing. Providing there was a fistula, or that the duct was drained to prevent back-pressure on the liver, he would use decholin to increase and maintain pressure in the common duct. He felt that by this method he not only washed the stone through, but also mucous plugs, blood-clots, and inspissated bile. In my case I used olive oil one hour after ether injection.

Raffl (1941), in experimental studies on the solvent action of ether, showed histologically that there was little resulting inflammatory reaction in the gall-bladder or bile-ducts, and that, providing the precaution of allowing the escape of ether vapour was taken, there was no disturbance of the liver, but that, if this was not done, it was a dangerous method.

Summing up, he felt that the use of ether in dissolving gall-stones will never replace surgical removal, but may be quite helpful in removing the overlooked stone, if it is discovered before drainage-tubes are removed.

A great opportunity was missed in my case—namely, to examine fully, quantitatively and qualitatively, the bile of this patient, who, for all her life, had been without a gall-bladder. It should show the changes in the bile that occur following cholecystectomy and might be of assistance in elucidating post-cholecystectomy symptoms.

SUMMARY

1. A case of congenital absence of the gall-bladder with common-bile-duct obstruction from stone is recorded. The patient had two other abnormalities in this region—a large quadrate lobe and what is presumed to be an abnormality of the lesser omentum.

2. A summary of a review of 71 cases made in 1948 is quoted.

3. Cholangiography was used in this case to demonstrate the absence of an intrahepatic gall-bladder, any remaining stones in the ducts, and the free pathway for bile into the duodenum. Information on this subject by other writers is summarized.

4. Ether was used to dissolve any remaining stones or biliary sludge, and its use and dangers as a solvent for gall-stones is reviewed.

I wish to thank Mr. W. H. Miller for allowing me to manage, and for permission to publish, this case. I am also indebted to Professor F. A. R. Stammers for his helpful criticism.

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THE FATE OF THE TUMOUR IN INFANTILE HYPERTROPHIC PYLORIC STENOSIS

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THE Fredet-Ramstedt operation of pyloromyotomy is now firmly established as the surgical treatment for infantile hypertrophic pyloric stenosis. Reduction in mortality from the 20 per cent considered so satisfactory in 1920 to the present 1 per cent in large clinics has simply followed the rigid adherence to principles crystallized about 1920. These principles are :—

1. Early diagnosis based on the palpation of the pyloric tumour. To the experienced physician, radiology has little to offer.

2. Rapid pre-operative correction of dehydration, control of infection, etc., no time being wasted on medical treatment.

3. Incision high in the epigastrium, above the liver margin.

4. Delivery of the pyloric tumour with minimal disturbance of the abdominal contents.

5. Incision into the pyloric tumour, the division of the muscle-fibres being completed with a blunt instrument, e.g., hæmostat.

6. Early discharge from hospital to avoid cross-infection, and to facilitate continuation of breast feeding.

The results of this régime can be so satisfactory that the experienced surgeon gives little thought to the condition. We found it stimulating, therefore,

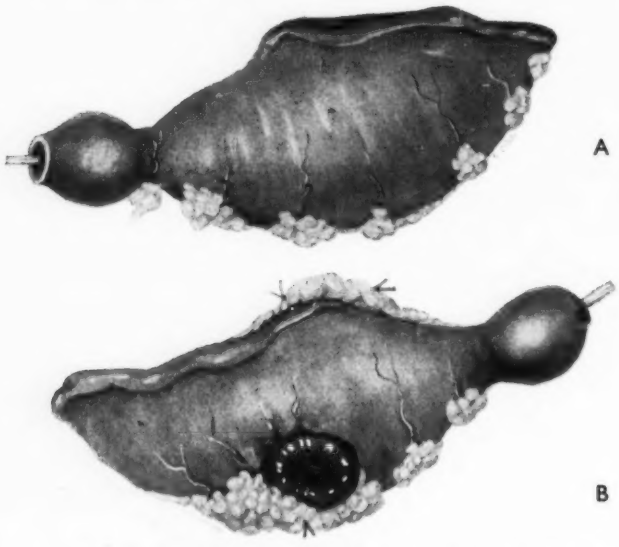

FIG. 53.—Colour painting of the specimen removed at operation. A glass rod has been passed through the pylorus, and the appearance of the tumour is well shown. The gastro-jejunostomy stoma has not grown to the large size reported in some cases. A, Anterior aspect of stomach; B, Posterior aspect showing gastro-enterostomy stoma.

to encounter a case treated before Ramstedt published his operation, and, since we have found no similar case record in the English literature, consider it worthy of publication.

CASE RECORD

Mrs. R. P., born Sept. 15, 1909.

In November, 1909, posterior gastrojejunostomy was performed for pyloric stenosis, with a very stormy convalescence.

As a child she was always delicate, and did not eat quite as much as other children—" when other children ate twenty cream buns, I ate ten ". She was educated at a boarding school, and was apparently normal, except for some discomfort after a heavy school lunch—" suet puddings never went down well ".

In 1935, after a big dinner at a hotel in Harrogate, she felt severe epigastric pain with nausea, rapidly leading to vomiting. She was admitted to a nursing home that night and kept under observation for a few days. A diagnosis of ' colitis ' was made, although she cannot remember any disturbance of her bowels. After this, she suffered with a very dry mouth after meals, giving difficulty in swallowing; she had an uncomfortable feeling behind the sternum after meals, although she refuses now to call this indigestion.

In September, 1935, it was recorded that she had had vague indigestion and three definite attacks of abdominal pain, starting round the umbilicus and settling in the right iliac fossa, with vomiting. On examination, there was tenderness in the right iliac fossa. X-ray examination showed very rapid emptying of the stomach through a gastrojejunostomy opening; very little of the barium meal entered the pyloric region of the stomach; gastro-jejunostomy appeared to be normal. A diagnosis of recurrent appendicitis was made, and the appendix removed through a crease incision; it was found to be kinked, infected, and adherent to the outer side of the cæcum.

She was disappointed to find that her symptoms were unrelieved following appendicectomy, although at no time after 1935 did she think it necessary to consult her doctor for indigestion. At times she could " eat an enormous meal and feel fine afterwards "; at other times, always in the evening, she felt an occasional slight pain in the midline of the epigastrium, associated with tenderness; this did not interfere with sleep and had always disappeared when she wakened in the morning. She was never troubled with pain during the night.

On April 6, 1950, at 4 p.m., during a train journey, she commenced with the usual midline epigastric pain, as a continuous ache associated with tenderness. She had been very well and free from pain for at least several days preceding this journey. The ache persisted, and was unchanged by a good meal which she enjoyed. She slept well and was surprised to find the pain still present when she wakened on April 7; it continued all day, despite a rest in the afternoon and a hot bath. Her customary evening gin increased the pain so much that she was unable to eat her dinner at 8 p.m.; however, after lying down for half an hour, she felt a little better and took her dinner. Immediately afterwards the pain increased; she vomited and lay on the floor in agony until helped to bed. The pain was continuous in character, and increased by movement.

Dr. M. S. Ross, of Hemsworth, was called and diagnosed an acute abdomen, which was confirmed by one of us (G. A.) after consultation.

Admitted to hospital at 2 a.m., April 8, she was obviously in pain and her abdomen was tender, the left iliac fossa being more tender than the remainder of the abdomen: there was generalized guarding without true rigidity. An X-ray examination of the abdomen revealed no gas under the diaphragm, and no abnormal gas shadows in the bowel.

AT OPERATION.—Under general anæsthesia, the abdomen was opened through a right paramedian incision. The peritoneal cavity contained about half a pint of thin turbid fluid with large flecks of fibrinous exudate, suggesting a perforation of the alimentary canal. Rapid inspection of the stomach and duodenum showed no evidence of ulceration. At this stage it was not known that a posterior gastrojejunostomy had been performed as an infant, and perforation by a foreign body was considered; the small bowel was examined, starting at the ileocæcal valve. No lesion was found until the duodenojejunal flexure was reached, where a perforated jejunal ulcer was discovered—even then it was only with difficulty that it could be established that a posterior gastrojejunostomy was present. Re-examination of the pyloric region revealed gross thickening of the pyloric canal, the appearance being identical with that seen at operation on infants with congenital pyloric stenosis; the patency of the pylorus seemed so doubtful that it was felt safer to perform partial gastrectomy than a simple closure of the perforation. Following subtotal gastrectomy with precolic gastrojejunostomy, her progress was uneventful except for a mild paralytic ileus about the end of the first week.

PATHOLOGY REPORT.—We are indebted to Professor M. J. Stewart for the following report:—

" The specimen consists of a portion of the stomach measuring about 7 cm. along the line of the lesser curvature and about 17 cm. along the line of the greater curvature. The pyloric portion of the stomach shows great muscular hypertrophy, involving approximately 5 cm. in the line of the greater curvature and 2·5 cm.

in the line of the lesser curvature. The diameter of the pyloric canal, which was packed out before fixation, ranges from 0·8 to 1·2 cm. On the posterior wall, close to the greater curvature, its lower margin 10 cm. from the pylorus, is the stoma of an old gastrojejunostomy measuring nearly 2 cm. in diameter. A narrow cuff of jejunal wall measuring from 0·5 to 1·2 cm. in width surrounds the orifice externally. There is only a minimal degree of peritoneal fibrosis in relation to the stoma, chiefly in relation to its upper margin. A focus of hæmorrhage 5 mm. in diameter is present in the thickened pyloric muscle in the line of the greater curvature. The mucosa of the pyloric canal appears to be thin and atrophic. The muscular wall of the rest of the stomach is about normal thickness and mucosal rugæ are not particularly prominent.

"*Histology*.—Two blocks of tissue have been taken, one in the line of the lesser curvature of the stomach, the other in the line of the greater curvature.

"1. *The block taken from the line of the lesser curvature* shows a very greatly thickened (hypertrophied) muscular coat, up to 7 mm. in thickness, and a greatly thinned and atrophic pyloric mucosa covering it. The thickening is essentially hypertrophic and, on the whole, the unstriped muscle presents a normal appearance. There is no appreciable excess of fibrous tissue except in certain limited areas and even here fibrosis is slight. Portions of Auerbach's plexus embedded in the muscle, though scanty, present no obvious pathological change. Ganglionic cells are reasonably well preserved and the nerve-fibre tissue shows no apparent abnormality.

"The pyloric-type mucosa over the hypertrophied portion of muscularis is thinned and atrophic and shows patches of unmistakable superficial (intestinal) heterotopia. Just before the duodenum there is considerable fibrosis of the muscularis, which is here thicker than higher up, and the submucosa at the pylorus shows intense vascular engorgement, many of the vessels containing a quite abnormally large number of neutrophil polymorph leucocytes. Indeed, one large venule contains almost as many polymorph leucocytes as red cells. The attached portion of duodenum—a narrow cuff—appears normal. The gastric mucosa above the hypertrophied portion of the pylorus appears to be thickened and almost polypoidal. It includes a small layer of fundal-type mucosa with abundant oxyntic cells.

"2. *Block taken from the line of the greater curvature*. The appearances in the muscularis are similar to those above described, but in addition there is a small focus of hæmorrhage in the submucosa, extending into the muscular coat. In the middle of this area of hæmorrhage there is a small contracted artery and several venules lying embedded in a mixture of blood and pus. The pus is the more centrally situated, immediately surrounding the thickened artery and an adjacent arteriole, while the peripheral part of the focus is pure extravasated blood, the infiltration of the muscular coat also being by blood only. There is no evidence of polyarteritis, but intermingled with the blood there are some curious lamellated structures of yellowish colour, both in the midst of the hæmorrhage and at its periphery. This appears to be due to a change in the walls of the fat cells in the submucosa and staining of these structures by extravasated blood pigment. The atrophy of the gastric mucosa is more limited in extent here than on the line of the lesser curvature. Auerbach's plexus is again well preserved.

"*Diagnosis*.—Old congenital hypertrophic stenosis at pylorus. Neonatal posterior gastrojejunostomy. Tiny submucous focus of suppuration. Great mucosal atrophy."

DISCUSSION

Although sporadic cases had previously been reported, interest in infantile hypertrophic pyloric stenosis appears to have been aroused primarily by Hirschsprung's description in 1888. James Nicoll (1900) claimed the first case successfully treated by operation, but later (1904) accorded this honour to Abel; Fisk (1906), however, mentions two cases in 1898, preceding Abel. The period 1900–20 appears to have been an experimental phase, with divulsion (Loreta's operation), gastrojejunostomy, and pyloroplasty as the bases for many variants, each carrying a general mortality of about 50 per cent, although individual surgeons could produce better results—e.g., Nicoll (1906) one death in six cases treated by

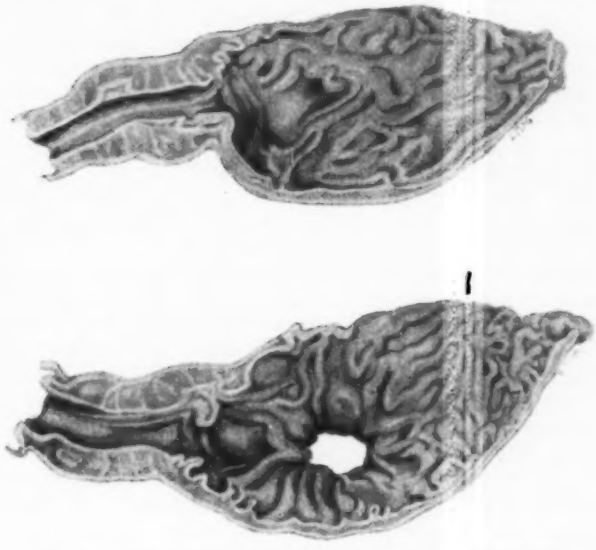

FIG. 54.—Colour painting of the specimen which has been divided longitudinally after fixation, the anterior half being shown above. It demonstrates the elongation and muscular thickening of the pyloric canal, protruding slightly into the duodenum.

divulsion and V-Y extramucous pyloroplasty. Walton (1914) knew Ramstedt's operation, but still considered gastrojejunostomy preferable, and as late as 1918, Jason-Wood in Bradford considered a single case of successful gastrojejunostomy worth publication in *The Lancet*.

The results of gastrojejunostomy are interesting, especially in relation to the aetiology of peptic ulcer. Holt (1917) followed several cases treated by gastrojejunostomy and found that, in their general development, they differed in no way from normal children. Fisk quotes the case of an infant treated by anterior gastrojejunostomy by Mikulicz; death occurred two months later "as a result of a diffuse intestinal hæmorrhage due to peptic ulcers in the wall of the duodenum opposite the anastomosis". Fowler and Hanson (1940) record the case of a male, aged 24, whose pyloric stenosis was treated by gastrojejunostomy at the age of six weeks in 1914; from 1932 to 1938 he suffered the symptoms of peptic ulcer, and was in hospital on three occasions for massive gastro-intestinal hæmorrhage. Stevens and Boeck (1944) surveyed the literature at that time, and report a case of their own, a male who had a gastrojejunostomy in 1911 and between the ages of 19 and 31 had nine severe hæmorrhages; at operation four jejunal ulcers were found. They quote Ruddock (unpublished), who treated two brothers for gastro-intestinal bleeding: they both had survived

gastro-jejunostomy in infancy—a sister in this interesting family was treated by Ramstedt's operation and was well. They also quote a case treated by Donovan (unpublished) of bleeding jejunal ulcer. Walters (1946) at the Mayo Clinic collected 5 cases of his own, all treated by gastrojejunostomy in the period 1910–15, and all suffering from gastro-intestinal hæmorrhage, often starting as early as 15 years of age. Two of these cases had previously been treated by pylorectomy without relief, and each had one further hæmorrhage after Billroth I gastrectomy. Stevens and Boeck conclude that it is essential to " take down " the gastrojejunostomy, and also do something to the pylorus—they regard pyloroplasty and gastrectomy as being equal in value; Walters used a Billroth I gastrectomy as a routine. Another of Walters's cases had previously suffered a perforation of a jejunal ulcer (sutured by the Donovan mentioned above); this is the only case of perforation that we have been able to find. Walters has also recorded the only female case in the literature.

In all these 11 cases, hæmorrhage was the major feature; dyspeptic symptoms were unusual, and in many cases a jejunitis rather than a chronic jejunal ulcer was reported. Our case of perforation brings the number to 12. While the early age of onset in many cases is suggestive, it is impossible to know the ' population at risk ', i.e., the total number of infants surviving gastrojejunostomy, and it is possible that these 12 cases represent a normal proportion of peptic ulceration, the site of the ulcer being determined by the anatomical arrangement; perhaps these are the people who ' normally ' would have suffered with duodenal ulceration.

It was soon recognized that gastrojejunostomy did not cure the pyloric stenosis. Scudder (1912) found that a barium meal passed through the gastrojejunostomy, none leaving the stomach by the pylorus. Holt corroborates this statement for the infant, and investigation of the cases of hæmorrhage listed above showed similar findings in the adult, except in Fowler and Hanson's case, where some barium could be forced through the pylorus. Walton found the pyloric tumour unchanged seven months after relief of symptoms by gastrojejunostomy, and Holt confirmed this observation, his cases being seen six months to four and a half years after operation. Fowler and Hanson's case, aged 24, was said to show the pyloric tumour, but their description—" the pyloric outlet seemed smaller than normal, barely admitting the tip of the index finger "—is not very convincing. Stevens and Boeck stated that " the hypertrophied muscle was still present " and Donovan described the pylorus in his case as " exactly like those found in cases operated on in infancy ". Walters gives the measurements of the three cases in which the pylorus was still present as: (1) 3·5–4 cm. long, 3 cm. thick; (2) Muscle 1·8 cm. thick, 2·5 cm. long; (3) Hypertrophy, the lumen being reduced to a dimension of 2 mm.

In our case, Professor Stewart's measurements are, we believe, convincing: the duration of forty years is the longest recorded at present.

The above observations on infants were made at autopsy following deaths from causes not related to the pyloric stenosis. Holt's child, aged 4½ years, was the subject of an operation for ventral hernia. The observations on the older patients are all, however, made on cases of peptic ulceration, and it may be argued that these are selected—i.e., when the pyloric tumour and stenosis disappear, the tendency to peptic ulceration is absent and the late result is not seen. We cannot, therefore, conclude that the pyloric tumour persists in the majority of patients treated by gastrojejunostomy, but must limit ourselves to the observation that in some patients it has remained undiminished. It will be seen that this reasoning is not compatible with the reasoning applied above to the question of peptic ulceration; either the pyloric tumour and obstruction persist in the great majority of cases, or their persistence gives a tendency to jejunal ulceration. While the latter postulate is in keeping with animal experimental work on peptic ulceration, further evidence is required before we can reach a sound conclusion.

The changes in the pylorus after Ramstedt's operation have been well described by Ransohoff and Woolley (1917) and Wollstein (1922). The wound in the pylorus is covered by serosa within nine days, and while the gap is slowly filling with fibrous tissue, atrophy of the pyloric muscle takes place; before the fibrous tissue has contracted to a fine scar the pyloric muscle has returned to a normal thickness (six weeks to three months). Parsons and Barling (1923) investigated their patients with radiology, and found rapid emptying of the stomach three weeks after operation, the rate being reduced to normal after nine months. Lanman and Mahoney (1933) extend the age of observation to seven years, a child dying from an unrelated cause showing an apparently normal pylorus. It may be concluded that Ramstedt's operation cures the pyloric lesion.

The results of medical treatment are more difficult to discover. For a period, it was maintained that any case which recovered on medical treatment was suffering from pylorospasm, rather than a true pyloric stenosis. Beardsley (1788) published a case which is still included in the history of infantile pyloric stenosis; this was an infant who started vomiting in the first week of life, and continued to vomit until death at 5 years of age; necropsy showed a scirrhous hypertrophy of the pylorus. Rosenheim described a case of a typical pyloric tumour in a child of 6½, who did not start with symptoms till the age of 5, and Holt a child of 4½ who was free from symptoms till the age of 3. These cases, however, are so at variance with modern ideas (Rosenheim's case was rejected by Nicoll in 1904) that doubt is cast on the diagnosis; it has been suggested that they represent cases of diaphragmatic obstruction, described by Landerer and Maier.

At present it is thought that if the infant can be kept alive, spontaneous relief of symptoms occurs within a few months, and the exponents of medical treatment claim a high percentage of cures in cases where the diagnosis has been adequately established.

According to Ramstedt (1912) Ibrahim recorded that post-mortem examination of several children, who had been cured by medical treatment and later died of other complaints, revealed the pylorus to be still in a hypertrophic condition.

Todd (1947) reported the case of a child who died two months after a clinical cure by eumydrin; at autopsy, the pylorus was normal. Todd also

investigated 34 children twelve to thirty months after clinical cure; a barium meal showed definite delay at the pylorus in 5, slight delay in 9, and no delay in emptying in 20. In older children, very few showed delay in emptying with narrowing of the pyloric antrum; it is emphasized that none of these children had persistent symptoms of pyloric stenosis. Wallgren (1946) also reported that the radiological signs of infantile pyloric stenosis—elongation, narrowing, and rigidity of the pyloric canal—persisted after clinical cure, even though the emptying time of the stomach was normal; after one to four years, however, peristaltic waves begin to pass over the pyloric canal and normal motility is reinstated. It appears, therefore, that after successful medical treatment, the pyloric tumour persists for months or years, but gradually disappears. Although localized muscular hypertrophy of the pylorus has frequently been recorded in adults, we have found no such case described that had the typical symptoms of pyloric stenosis in infancy, and it is thought that there is no connexion between the two conditions.

Why the pyloric tumour should persist after gastrojejunostomy and regress after medical treatment is not clear. In the present state of our knowledge of the causation of pyloric stenosis, speculation appears profitless—but that the tumour does persist is a fact that must be explained by any future theory concerning the nature of infantile hypertrophic pyloric stenosis.

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ANNULAR PANCREAS

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THE encirclement of the second part of the duodenum by an annular extension of the pancreas is a rare abnormality. In 1933 McNaught published a review of the literature in which he summarized the findings in 40 such cases. Stofer (1944) added 7 more to the list, and 5 other single cases have been reported, thus making a total of 52 (Lehman, 1942; Chapman and Mossman, 1943; Custer and Waugh, 1944; Gross and Chisholm, 1944; Goldyne and Carlson, 1946). Although most of these cases died of causes unrelated to the pancreatic abnormality, many having lived to an old age, the annulus was often noted, nevertheless, to have caused some degree of duodenal constriction with consequent dilatation of the proximal duodenum and sometimes of the stomach. In 14 cases the constriction gave rise to severe symptoms necessitating surgical relief. In 2 cases acute pancreatitis was a fatal complication. The following case is almost unique in that the condition was associated with jaundice due, in our opinion, to recurrent subacute pancreatitis affecting the annulus.

CASE REPORT

Mrs. E. R., aged 32 years, was admitted on Nov. 26, 1949, to the Broadstone Jubilee Hospital, Port Glasgow. Three days previously she was suddenly seized with a pain of overwhelming severity in the lower epigastrium, radiating to the right hypochondriac and right infrascapular areas; frequent bouts of vomiting and retching added to her distress. Jaundice appeared on the third day of illness.

Earlier in the same year, in April and again in June, she had had similar attacks of pain but of lesser severity, each lasting about five days. She first became jaundiced during the second episode. In between these illnesses she was relatively well and in August she was delivered of a full-term child.

PHYSICAL EXAMINATION.—The temperature was 102° F., pulse-rate 72, respiratory rate normal. The patient was moderately jaundiced, but appeared to be otherwise healthy. She was not in severe pain and the abdomen moved freely with each respiration. Deep tenderness without muscle guarding was elicited in the region of the gall-bladder, which was not palpable. Physical examination gave no other noteworthy findings.

The stools were at first acholic; the urine on admission was acid, specific gravity 1010, and contained albumin and bile.

COURSE OF ILLNESS.—During the next five days the jaundice disappeared and the temperature settled; the abdominal pain and nausea subsided and the patient's condition steadily improved. Cholecystography, performed fifteen days after admission to hospital, failed to demonstrate the gall-bladder and showed no abnormal opacities. The serum-amylase during the third week of illness was within normal limits.

A presumptive diagnosis of intermittent biliary obstruction due to gall-stones was made, and laparotomy was carried out eighteen days after admission to hospital.

OPERATION (H. W.).—The gall-bladder had a slightly thickened wall but was flaccid and did not show any sign

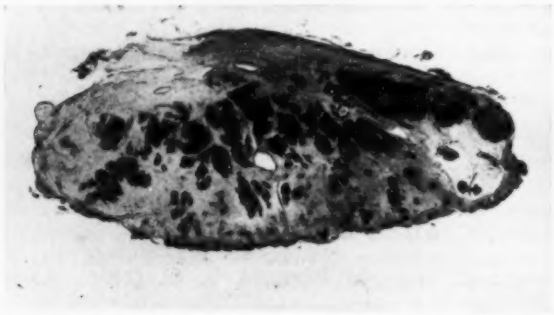


FIG. 55.—A transverse section of the excised portion of the annulus. The longitudinal muscle coat of the duodenum is seen along the lower margin while the upper surface is lined by peritoneum. The main annular duct is seen in cross-section in the middle of the section. (Hæmalum and eosin.) (× 3·3.)

of recent inflammation. No stones could be felt inside. Both the cystic and common bile-ducts were very considerably dilated and also appeared to be free of stones. The liver showed no abnormality. In searching further for the cause of the jaundice, the ring pancreas was discovered. Once the mesocolon had been detached by

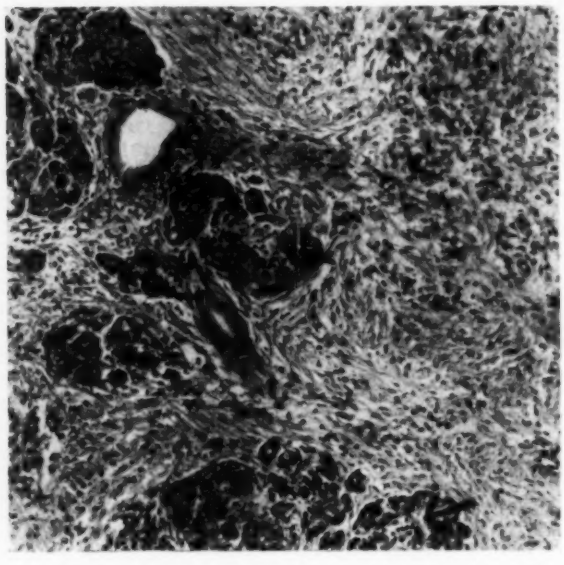


FIG. 56.—Groups of acini, ducts, and islet tissue (arrows) are embedded in dense fibrous tissue. In the upper right corner of the field are the remains of atrophic acini. Lymphocytes and mononuclear cells are scattered throughout the fibrous stroma. (Hæmalum and eosin.) (× 125.)

gauze dissection, a good exposure of the second part of the duodenum was obtained.

The annulus bore a certain resemblance to a signet ring, measuring in width approximately 1·5 cm. anteriorly and 2·5 cm. posteriorly, and approximately 1 cm. in thickness. The ectopic tissue had a nodular surface and felt unduly firm; it completely encircled the second part of the duodenum but did not cause obvious constriction. The stomach, intestines, appendix, and spleen all appeared to be normal.

The patency of the common bile-duct was tested in the usual manner through a supraduodenal approach; no stones were found therein and a medium-sized urethral sound was passed without hindrance into the duodenum. The bile was amber-coloured and quite clear; drainage was provided by an indwelling T-tube.

In view of the absence of any demonstrable blockage or stenosis of the common bile-duct, it was considered that the symptoms might be causally related to the ring pancreas, the firmness and rigidity of which pointed to the presence of chronic inflammatory change. Resection of a segment of the ring seemed to offer a good chance of permanently relieving any pressure on, or distortion of, the common bile-duct. This was carried out without difficulty, although adherence to bowel wall was so intimate that most of the outer muscle coat had to be sacrificed. The cut surfaces of the ring presented

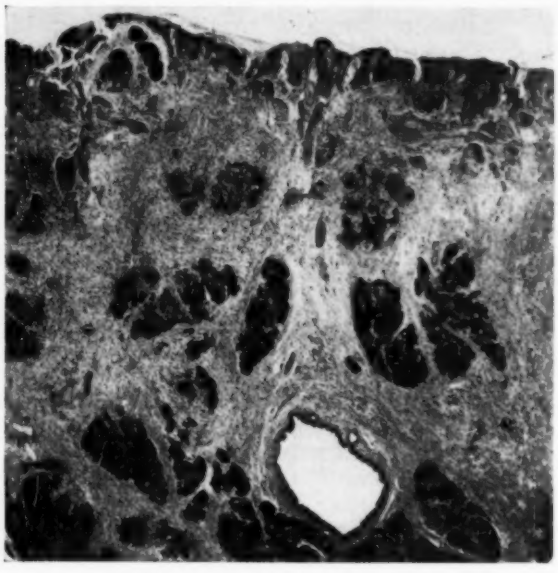


FIG. 57.—A higher magnification of part of *Fig.* 55, showing the main duct, and occasional tributaries cut obliquely. The outer part of the muscle coat of the duodenum bounds the surface.

a yellowish, fibrous appearance. Marginal oozing was easily controlled. *Biopsy* was performed upon the body of the pancreas.

POST-OPERATIVE COURSE.—The patient vomited once or twice each day for the first week, after which convalescence was uninterrupted.

POST-OPERATIVE INVESTIGATIONS.—

1. *Bacteriology of Bile from Common Duct.*—No organisms were seen on direct examination and no growth obtained on culture.

2. *Pathological Report* (J. R. A.).—The excised portion of the annulus was firm and retained the shape of a segment of a ring. In transverse section (*Fig.* 55) it measured 2·0 by 0·7 cm.; one surface was coated with smooth muscle of the duodenal wall, while the other was lined by peritoneum.

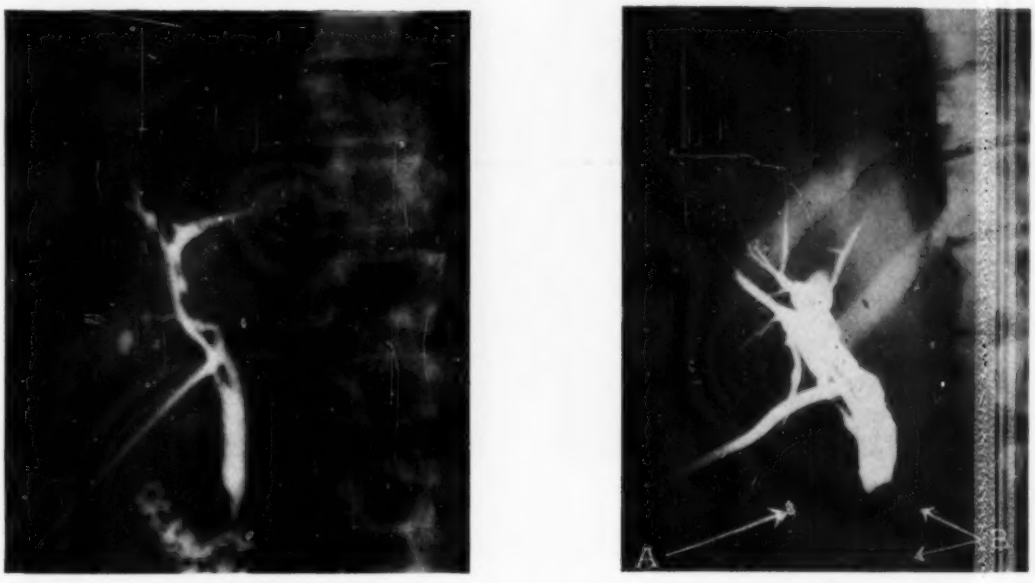
Microscopically a cross-section of the annulus showed it to consist of dense fibrous tissue in which were embedded groups of normal and atrophic pancreatic acini, and occasional small islets (*Fig.* 56). A single duct of 1 mm. diameter was seen to be cut in transverse section with smaller tributaries cut obliquely (*Fig.* 57). There was patchy aggregation of lymphocytes and mononuclear cells throughout the fibrous tissue, related particularly to groups of atrophic acini.

The biopsy taken from the body of the pancreas consisted of normal tissue.

3. *Cholangiography.*—This was carried out fourteen days after operation by injection of lipiodol via the T-tube

in the common bile-duct and showed an incomplete obstruction at the distal end of the common duct. Further cholangiograms taken three days later also showed some delay in the passage of the lipiodol (*Fig.* 58). It should be stated that no opiate or other drugs were administered prior to these examinations. Another interesting feature was the visualization of the duct of the annulus (*Fig.* 58 B).

4. *Barium-meal Examination.*—This was carried out two weeks after operation, and showed an obstruction of



A B

FIG. 58.—A, A normal cholangiogram in which the common bile and hepatic ducts are visualized, with some retrograde filling of the gall-bladder; passage of some of the contrast medium into the duodenum has occurred. B, Cholangiogram of the case reported, showing dilatation of the biliary passages. An arrow (A) indicates the small duct opening into the common bile-duct and considered to be that draining the annulus. (B) marks the narrow track of contrast medium passing into the duodenum.

smooth, rounded outlines in the second part of the duodenum, through which the barium trickled along the pancreatic border (*Fig.* 59 A). The stomach was not abnormally dilated although gastric emptying was slow. A second barium-meal examination was performed six weeks later with similar findings, but with a slightly lesser degree of duodenal constriction (*Fig.* 59 B), while a third examination six months later showed neither obstruction nor deformity of the duodenum (*Fig.* 59 C).

DISCUSSION

The *clinical complex* in this case is unusual, and apart from a case reported by Reitano (1932), of a five-month-old infant, we have not found an instance in which an annular pancreas gave rise to obstructive jaundice. The pre-operative course suggested that the patient was suffering from repeated attacks of acute cholecystitis associated with gall-stones, but no stones were found at operation, nor was there any outward sign of recent inflammatory change, while the sample of bile taken from the common bile-duct was sterile. A bougie was passed along the common duct into the duodenum without difficulty, yet the degree of dilatation of the common and cystic ducts was such as not to be ignored. The cholangiograms taken after operation proved conclusively that there was a partial obstruction of the common bile-duct near its termination. Indeed, the appearances suggested that the duct had become permanently kinked at the part of its course that lay within the ring.

The *histopathology* of the excised piece of the ring threw further light on the problem. The picture of acinar loss with replacement by fibrous tissue encouraged the belief that the annular portion of the pancreas had been the seat of repeated attacks of subacute pancreatitis and the history of the case is not inconsistent with this interpretation. The serum-amylase test, performed at the time it was, gave not unexpectedly a normal result. Accordingly, it is suggested that the jaundice which appeared during the second and third episodes was due to compression of the common bile-duct during more active phases of the pancreatitis.

That the annular pancreas is prone to chronic inflammatory change is evidenced from Lehman's observation that in all five operation cases in which a portion of the ring was examined histologically, chronic pancreatitis was observed. Lehman considers that this may be due to increased pressure in the abnormal tortuous annular duct, caused by peristalsis and ballooning of the duodenum. Acute pancreatitis has been noted in two instances (Benedetti, 1920; Brines, 1930). The observation that in some cases (McNaught and Cox, 1935; Goldyne and Carlson, 1946) the annulus has been composed of normal pancreatic tissue, suggests the probability that when fibrosis does occur, it is due to obstruction or inflammatory changes, and is not merely a feature of the ectopic tissue.

Roentgenological studies offer the best and indeed the only means of arriving at a definite diagnosis—that is to say, provided the possible existence of this rare abnormality is borne in mind. The appearances after an opaque meal have been variously reported as a "partial obstruction", "constricting

ulcer ", " polyp ", and " diverticulum " of the second part of the duodenum. Only in Lehman's case was the correct presumptive diagnosis made before laparotomy. In our case the radiological studies were carried out post-operatively. Barium-meal examination was performed on three occasions over a period of seven months: the first and second revealed a narrowing and partial hold-up at the site of the ring. Having established the patency of the duodenum at that level at operation, we interpreted the appearances as being due to segmental spasm of the gut wall following interference with the myenteric nerve-plexus. The final examination showed a complete return to normal form and function. It is as yet too early to say whether or not the biliary obstruction has been permanently relieved, although the patient's progress to date has been encouraging.

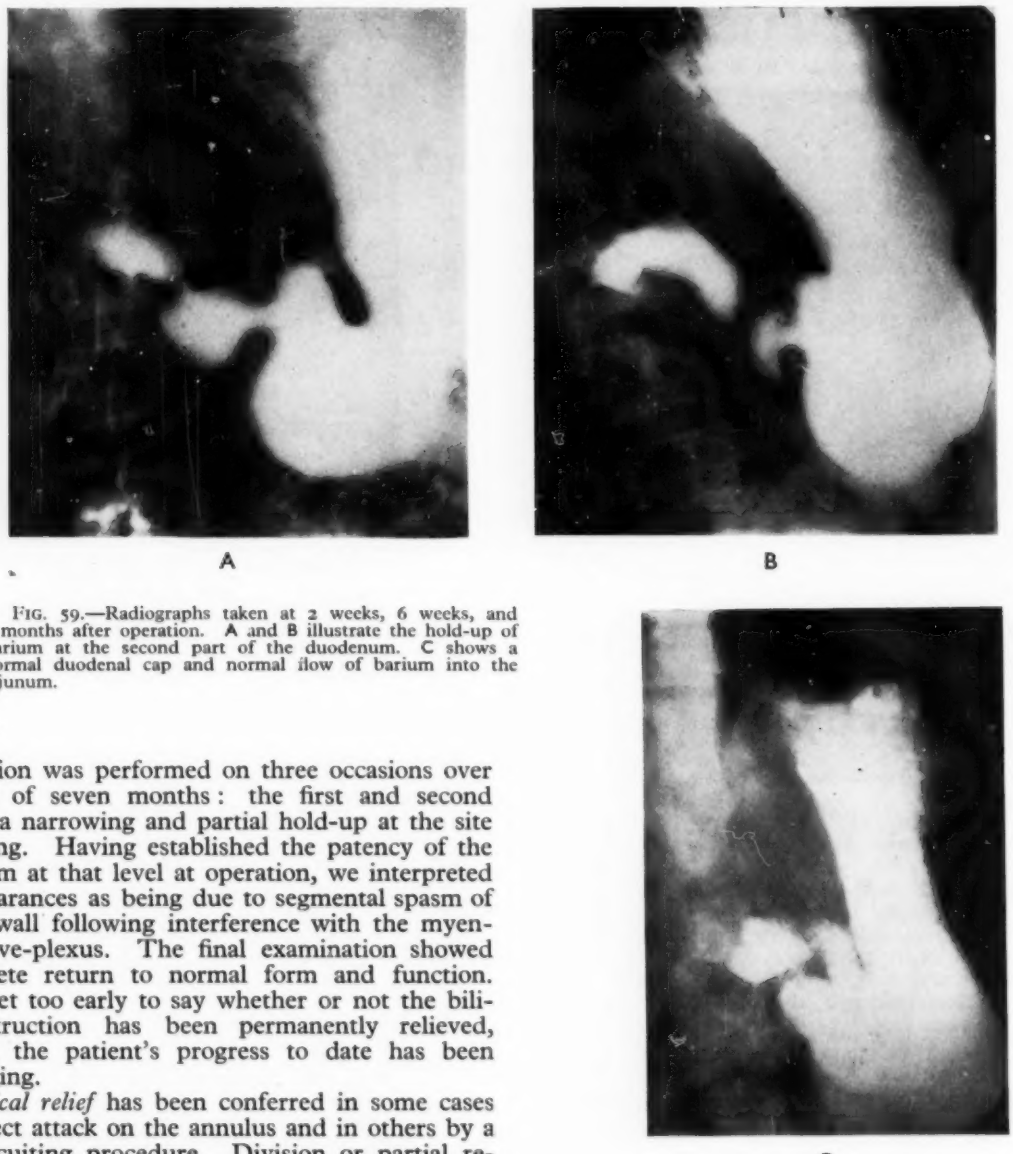


FIG. 59.—Radiographs taken at 2 weeks, 6 weeks, and 3 months after operation. A and B illustrate the hold-up of barium at the second part of the duodenum. C shows a normal duodenal cap and normal flow of barium into the jejunum.

Surgical relief has been conferred in some cases by a direct attack on the annulus and in others by a short-circuiting procedure. Division or partial resection was performed on 5 patients with success. This method carries with it the risk of cutting a sizeable duct, which might lead to a pancreatic fistula. Some leakage occurred in Zeck's case (1931), and Howard (1930) found that he had to deal with a pseudopancreatic cyst before a complete cure was effected. It is for this reason that the body of opinion seems to favour measures that side-track the site of obstruction. There are 5 records of gastroenterostomy having been performed: three of the patients died, the cause of death in each case being a respiratory infection. The surgical treatment carried out on these three cases can scarcely be described as elective, because the real character of the obstructive lesion became apparent only at necropsy. So far as we know, duodenojejunostomy has been performed once and with a satisfactory result (Gross and Chisholm, 1944). The patient was a 3-day-old infant whose colon was mal-rotated, so that the existing conditions were highly suitable for the performance of what would otherwise have been a rather difficult procedure.

In our case the choice lay between resection of the annulus and cholecystojejunostomy. Considering the dilated state of the common duct at the time of operation, it seemed unwise to expose the liver to the threat of an ascending infection. Partial resection of the annulus proved to be technically easy and was followed by no untoward complications. Perhaps we were fortunate in this respect, but it is our opinion that if due regard is paid to hæmostasis and an attempt made to occlude any ducts, whether visible or not, by a running stitch of non-absorbable material, little harm should result. It may happen,

as was Zeck's experience, that the exposed segment of duodenum fails to expand, in which case the bowel may be incised in its longitudinal axis and the wound sutured in the transverse, as Zeck did; on the other hand, gastro-enterostomy may be safer, especially in cases where the gut wall is somewhat thinned, as it was in our case, by the stripping of the outer layer of the muscle coat.

The coexistence of a peptic ulcer will also be a matter for consideration in deciding the line of treatment. A gastric ulcer was noted in 4 of the 14 cases that required surgical attention. In one of these (Custer and Waugh, 1944) cure was effected by a subtotal gastrectomy. This may seem a high incidence, but, as Lehman points out, the frequency of peptic ulceration among the general population is such as to cast doubt upon the significance of its association with annular pancreas. It may be that in these cases there is a degree of gastric stasis or some interference with the reflux of the alkaline contents of the duodenum.

Aetiological considerations of annular pancreas depend upon an understanding of the normal development of the organ, excellent accounts of which are available (Baldwin, 1910; Lecco, 1910; McNaught, 1933). Briefly, it may be noted that the pancreas develops from two outgrowths, one dorsal and one ventral, from the part of the gut destined to become the second part of the duodenum. The dorsal outgrowth forms the tail, body, and all but the lower right quadrant of the head of the pancreas. The ventral outgrowth consists of two buds arising one from either side of the common bile-duct; the left bud normally atrophies in humans and disappears, while the right one persists. As the gut enlarges and rotates, the ventral anlage, in company with the common duct, migrates dorsally around the right side of the bowel and fuses with the dorsal to form the remaining part of the head of the composite organ, which by further rotation comes to lie to the left of the second part of the duodenum. Each

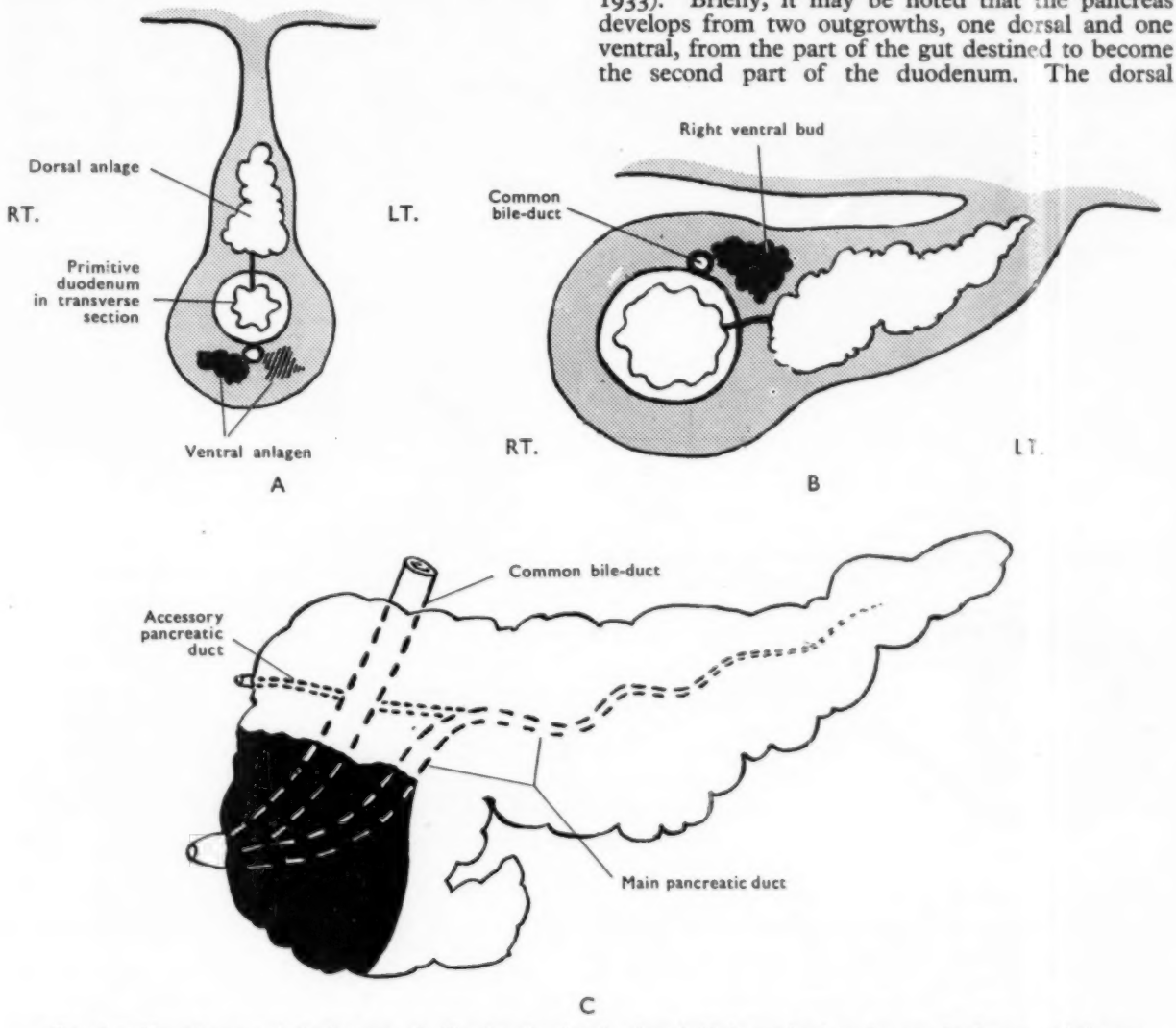


FIG. 60.—*Normal pancreatic development.* A, Showing the dorsal anlage (white) growing into the mesoduodenum, and the two primordia of the ventral anlage lying on either side of the bile-duct; the right (black) persists, the left (shaded) atrophies or fuses with the right bud. B, Later stage. Duodenum swinging to the right, while the bile-duct and right ventral pancreatic bud migrate dorsally and approach the dorsal pancreatic outgrowth. C, Adult form, showing the parts of the pancreas formed by the ventral (black) and dorsal (white) anlagen and the usual arrangement of the ducts. When an annulus is present, its duct usually enters the main pancreatic duct close to its termination.

pancreatic outgrowth has a single main duct, and these also unite. That of the dorsal anlage persists as the main duct which traverses the tail, body, and part of the head, where it becomes confluent with the duct of the ventral anlage, which contributes the terminal part of the main duct. This is the explanation for the peculiar S-shaped course taken by the duct of Wirsung through the head of the pancreas.

which would explain the case described by Cunningham (1910) in which the annular duct opened into the common bile-duct in a plane slightly posterior to the entrance of the main pancreatic duct (*Fig.* 61 B).

Tieken (1901) suggested that the annulus was hypertrophic in nature, ventral and dorsal enlargements of the head of the organ extending to the right, and uniting on the right side of the duodenum. Lerat (1910) supported this view and considered that the hypertrophy might result from pancreatitis *in utero*. The hypertrophic theory receives little support from the cases in which careful study of the duct system has been made, a study which has been facilitated by the injection and radiological technique

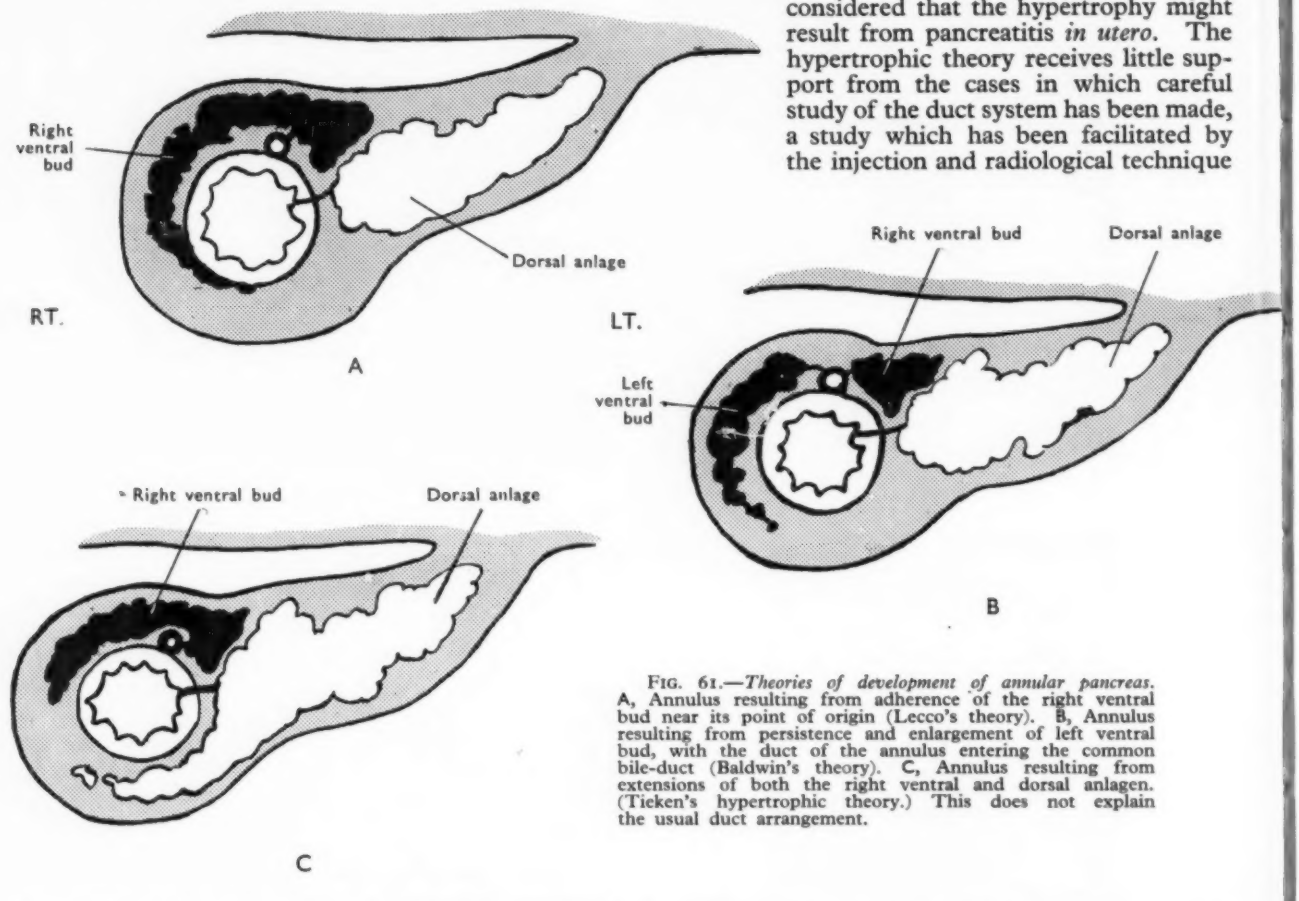


FIG. 61.—*Theories of development of annular pancreas.* A, Annulus resulting from adherence of the right ventral bud near its point of origin (Lecco's theory). B, Annulus resulting from persistence and enlargement of left ventral bud, with the duct of the annulus entering the common bile-duct (Baldwin's theory). C, Annulus resulting from extensions of both the right ventral and dorsal anlagen. (Tieken's hypertrophic theory.) This does not explain the usual duct arrangement.

The dorsal anlage may retain its original connexion with the duodenum through the accessory duct of Santorini, which emerges proximal to the ampulla of Vater (*Fig.* 60).

In 17 of the 20 cases of annular pancreas in which the duct system has been adequately studied, the annulus had a single main duct originating in the portion of the ring overlying the left anterior surface of the duodenum, then sweeping dorsally around the right side of the duodenum, crossing the gut posteriorly from right to left, and opening into the main pancreatic duct close to the ampulla. This anatomical arrangement indicates that the annulus is derived from the ventral anlage, and Lecco (1910) considered that the anomaly may result from adherence of the tip of the right ventral pancreatic bud to the duodenal wall, with the result that during migration dorsally a band of pancreatic tissue becomes stretched around the duodenum (*Fig.* 61 A). Though in agreement with this hypothesis, Baldwin (1910) believed that the left ventral bud might sometimes persist and enlarge to form an annulus, a suggestion for post-mortem material described in 1935 by McNaught and Cox (*Fig.* 61 C).

Thür (1929) reported a case in which the duct of the dorsal anlage formed the main duct of the pancreas, Wirsung's duct remaining small and separate; the annular duct passed around the right side of the duodenum, to the left across the anterior surface, and united with the duct of the dorsal anlage. In this case the annulus was deficient posteriorly, and its duct was largest anteriorly. In Bell's case (1922) the annular duct opened directly into the duodenum above and posterior to the ampulla. It is difficult to believe that the annuli in these two cases arose from the ventral anlagen. The pancreas is, however, untidy in its development, as seen by the occasional finding of ectopic pancreatic tissue embedded in the duodenal wall and elsewhere, reminiscent of the condition normally seen in fishes, and it seems not unreasonable to suppose that such ectopic tissue may occasionally come to surround the gut as a result of some error in the developmental rotation of the latter. Chapman and Mossman

(1943) draw attention to the comparative anatomical studies of the pancreas made by Hill (1926), who showed that the bird's pancreas is a tripartite structure, the dorsal and two ventral outgrowths remaining separate and each having a separate duct system. The crocodile, which approaches the bird in the anatomy of the duodenal region, has a double pancreas, one lying ventral to the duodenum, the other dorsal. In our case the annular duct appears to enter the right or posterior aspect of the common bile-duct (*Fig.* 58), an arrangement similar to that noted by Cunningham (1940). If this interpretation of the cholangiogram is correct, then the annulus has probably arisen from the sinistral bud of the ventral anlage, and the abnormality could be regarded as atavistic in nature.

The practical implication of these aetiological considerations is seen in the surgical treatment of annular pancreas, where it should be noted that in the majority of cases the annular duct originates over the left anterior part of the duodenal wall, and that the annulus itself is normally somewhat attenuated at this site. Accordingly, in performing incision or resection of the ring, the site of election is that part overlying the left anterior surface of the duodenum.

SUMMARY

A case of annular pancreas is reported in which the presenting symptom was jaundice, apparently due to pressure on the lower end of the common bile-duct by the inflamed pancreatic annulus. Partial resection of the ring has been followed by freedom from symptoms.

The aetiology, pathology, diagnosis, and treatment of annular pancreas are briefly discussed.

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ANNULAR PANCREAS

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LATE WING COMMANDER R.A.F., MEDICAL BRANCH
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LATE LIEUTENANT-COLONEL, R.A.M.C.

ANNULAR pancreas is a rare condition, usually discovered at autopsy or in the dissecting room. Fifty-eight cases have up to the present time been recorded in the literature, but only 17 of these have been the subject of clinical study during their lifetime. It seems, therefore, to be of interest to describe a further case, which appears to be the first reported in Great Britain.

CASE REPORT

Leading Aircraftman H. H. S., aged 25, serving in Germany with the R.A.F., was perfectly well until about Sept. 10, 1945. He had a sudden loss of appetite, accompanied by epigastric pain occurring about one hour after a meal. Four days later he began to vomit rather copiously and was constipated. Vomiting, which gave relief, occurred with increasing frequency, and on Oct. 3, 1945, he was admitted to the 9th (British) Military Hospital, Hamburg, under the care of one of the authors (J. C. F. Ll. W.). Further questioning elicited no more positive information, and there was no history of previous indigestion or other illness.

He was thin and dehydrated, but not anæmic or cachectic. There was no jaundice. His mouth and tongue were dry. The outline of a distended stomach was clearly visible, with waves of peristalsis passing across it. There was a marked succussion splash. No tumour was palpable, and there was no ascites. Rectal examination was negative. Major Hanson, R.A.M.C., reported that a barium meal showed obstruction in the second part of the duodenum near the junction with the first part. The obstruction was marked, but not complete, and there was considerable gastric distension; *Figs.* 62, 63 show this clearly. Fractional test-meal showed no reduction of gastric acidity. Blood-count, Kahn reaction, and urinalysis were normal.

He was given normal saline solution intravenously and rectally with rapid improvement: His blood-urea dropped from 92 mg. to 47 mg. per 100 ml. His appetite began to return, but the duodenal obstruction, as shown by a further barium-meal examination, persisted.

He was shown at a Clinical Meeting at the Hospital on Oct. 23, and all the rare possible causes of such obstruction culled from the small print of the radiological text-books, including annular pancreas, were mentioned.

On Oct. 30 he was transferred to the United Kingdom and admitted to the R.A.F. Hospital at Wroughton, Wilts., where he came under the care of the other writer (B. J. B.).

At this time he felt well except for occasional burning epigastric pain, unrelated to food. He had lost 30 lb. in weight since the onset of his illness.

On examination, his physical signs were similar to those previously detailed, and visible gastric peristalsis was present one-and-a-half hours after his last meal. Chvostek's sign was not elicited.

Pathological examination gave the following data: Hæmoglobin 102 per cent; R.B.C. 5·2 million/c.ml.; W.B.C. 7200/c.ml.; serum-calcium 8 mg./100 ml.; urinary chlorides absent.

A third barium-meal examination was carried out by S/Ldr. K. D. Forgan Morle, who reported: "Œsophagus normal. The stomach is large, but otherwise appears normal, with a good mucosal pattern and good tone. The meal can be easily expressed into the duodenal cap, which is very large indeed, but which also shows good tone and is capable of vigorous peristalsis. Careful and rather prolonged screening showed an almost total obstruction of the second part, with only an occasional trace of barium passing through a very narrow orifice. The condition at eight hours is similar to that at the start. Practically total obstruction of the second part of the duodenum of unknown aetiology."

FIG. 62.—Barium-meal radiograph at 18 hours showing distension of stomach and first part of duodenum.

FIG. 63.—Lateral view of duodenum showing distension of proximal part of duodenum and constriction ring in second part.

It was not possible to arrive at a positive diagnosis, but the presence of some congenital abnormality was postulated, possibly a duodenal mesentery, with partial obstruction made complete by the huge distension of the stomach.

AT OPERATION.—Laparotomy was decided upon, and was performed on Nov. 12 (B. J. B.). There was a small amount of free fluid in the peritoneal cavity, with some œdema of the greater omentum. The whole of the pancreas was enlarged, hard, and nodular, and a ridge of hard tissue extended to the right in front of and around the second part of the duodenum, causing the obstruction in this region (*Fig.* 64). The process was thought to be carcinomatous, but the pancreas did not seem to be tightly bound down to the posterior abdominal wall, and there were no metastatic deposits in the liver or elsewhere. A posterior gastrojejunostomy was performed, and convalescence was entirely uneventful. His symptoms were completely relieved.

Test for pancreatic function after operation revealed no defect of intestinal fat-splitting power, and the serum-amylase was not raised.

At the suggestion of Air Vice-Marshal Sir Stanford Cade he was admitted to the Westminster Hospital for possible radiotherapy. On further consideration and in view of his very good general condition, it was thought unlikely that he was suffering from a carcinoma, but from chronic inflammation in an annular pancreas. That this was the true diagnosis is confirmed by the fact that he has remained well since his operation, has married, and has a family. He has occasional dyspeptic symptoms, but reports (October, 1950) that he is in good health and doing full work.

DISCUSSION

Annular pancreas is an uncommon condition. Baldwin (1910), reporting a case, detailed 8 cases described in the literature up to that time. By 1933 the total had risen to 41 (McNaught, 1933). In 1942, 48 cases had been described, and Lehman (1942) added another. Since then Chapman and Mossman (1943), Stofer (1944), Gross and Chisholm (1944), Custer and Waugh (1944), Goldyne and Carlson (1946), Nedelec (1946), Brown, Bingham, and Cronk (1948), Burger and Alrich (1949), and Ohlmacher and Marshall (1950), have brought the total to 58.

In view of the increasing frequency of case reports, the incidence of this abnormality is probably greater than is generally realized.

In the great majority of cases, and particularly in the early reports, the condition has been only diagnosed after death. Only 9 of the 41 cases reported by McNaught (1933) are noted as having had symptoms and signs during life. In 20 per cent of the autopsy or anatomical department specimens recorded by Gross and Chisholm (1944) other congenital abnormalities were present (i.e., duodenal or anal atresia, or a cardiac abnormality).

Annular pancreas produces symptoms either in the newborn baby (when it may be associated with jaundice, and, if untreated, is usually fatal within a few months) or in adult life. In McNaught's series the ages ranged from 26 to 74, but since then younger cases aged 17 and 25 have been reported. McNaught noted that 61 per cent of the operated cases, and 77 per cent of all cases, in which the age was stated, were males.

It is interesting to speculate on the reason for this sex incidence and why these cases remain silent, at least till early adult life. Does something (perhaps the irritation of food "passing the narrows") cause pancreatitis and so increase the obstruction?

In almost every case the symptoms and signs were those of acute or recurrent duodenal obstruction. Rarely, and then chiefly in infants, jaundice may be present.

Radiological investigation shows that the obstruction is in the second part of the duodenum and the defect may be incisura-like. This should make one suspicious of an annular abnormality of the pancreas.

In 3 cases duodenal diverticulitis was suspected by the radiologist.

Even at laparotomy this cause of obstruction, owing to its rarity, may not be considered and so not spotted: and, as there is on occasion an associated pancreatitis, the pancreas may appear nodular and as if carcinomatous. Lehman (1942), in describing his case, stated that at operation the pancreas appeared nodular and malignancy was suspected; a nodule was removed, and, while the surgeon was waiting for the report of the frozen section, he discovered the annular condition and proceeded to divide the thin band constricting the duodenum.

In the authors' case, although the annular nature of the pancreas was observed, the pancreas was considered to be malignant owing to its hardness and the irregularity of the surface.

Dozzi (1946) describes the formation of the abnormality and its varieties. He supposes that it results from the persistence of the left half of the ventral anlage, which ordinarily atrophies. Lecco (1910), cited by Lehman (1942), postulates a failure of the proper assemblage of the ventral bud characterized by a persistence of its tip in an anterior position.

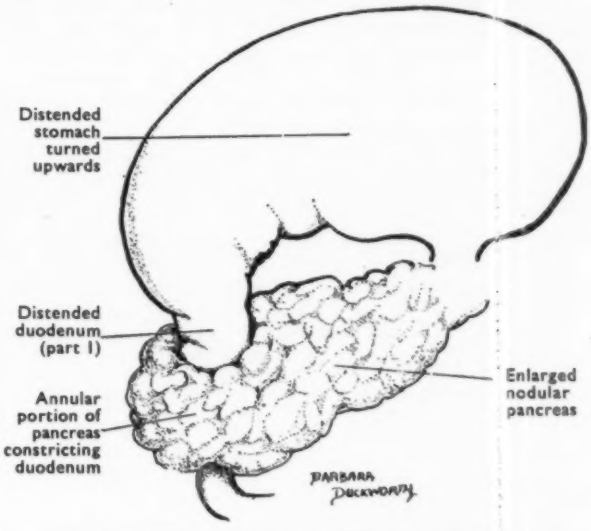

FIG. 64.—Diagram showing condition found at operation. The enlarged and nodular pancreas surrounds and constricts the second part of the duodenum. The stomach has been turned upwards.

Usually the pancreatic tissue completely encircles the duodenum, producing some measure of compression, but sometimes there is a slight gap, usually anteriorly. Stofer (1944), however, describes a case where the weakest part of the ring was posterior. The anomalous ring tissue cannot be distinguished histologically from normal pancreas and possesses a

Table I.—REPORTED CASES TREATED BY OPERATION

CASE	REPORTER	AGE	SEX	OPERATION	RESULT
1	1905, Vidal	3 d.	M.	Posterior gastro-enterostomy	Cure
2	1906, dos Santos	26 yr.	F.	Posterior gastro-enterostomy	Died
3	1908, Lerat	46 yr.	F.	Resection of pancreatic ring	Cure
4	1928, Smetana	74 yr.	M.	Posterior gastro-enterostomy	Died
5	1930, Howard	46 yr.	F.	Division of ring	Cure
6	1930, Brines	35 yr.	M.	Drainage of pancreatitis	Died
7	1931, Zech	27 yr.	F.	Division of ring. Plastic operation on duodenum	Cure
8	1931, Brines	44 yr.	M.	Posterior gastro-enterostomy	Died
9	1940, Truelsen	35 yr.	M.	Posterior gastro-enterostomy. Plastic operation on duodenum	Cure
10	1942, Lehman	23 yr.	M.	Partial resection of ring	Recovery, but persistent symptoms
11	1944, Gross and Chisholm	3 d.	F.	Duodenojejunostomy	Cure
12	1944, Custer and Waugh	72 yr.	M.	Gastric resection and anterior gastro-enterostomy	Cure
13	1946, Goldyne and Carlson	26 yr.	M.	Resection of ring	Cure
14	1946, Nedelec	17 yr.	M.	Posterior gastro-enterostomy	Cure
15	1948, Brown, Bingham, and Cronk	53 yr.	F.	Resection	Died
16	1949, Burger and Alrich	4 d.	F.	Resection and duodenal plastic	Died
17	1950, Ohlmacker and Marshall	27 yr.	M.	Partial gastrectomy with posterior gastro-enterostomy	Cure
18	1950, Bickford and Williamson	25 yr.	M.	Posterior gastro-enterostomy	Cure

duct system of its own, which, commencing anteriorly, passes first to the right and then around the right side and back of the duodenum to the head of the pancreas, where it usually joins the main duct. It may end separately in the common bile-duct (Cunningham, 1940).

Treatment and Progress.—Obstruction of the duodenum sufficient to produce symptoms can only be remedied by surgery. This may take the form of either: (1) division or partial resection of the ring; or (2) some form of by-pass operation, gastrojejunostomy, duodenojejunostomy, or, as in two recent cases (*Cases* 12 and 17, *Table I*) partial gastrectomy with gastrojejunostomy. From this table the results may be grouped as in *Table II*.

Table II.—Results of Operations

	Direct			Indirect		
	Division of Ring			Gastrojejunostomy (or with partial gastrectomy)		
	Recovered	*Died*	*Total*	*Recovered*	*Died*	*Total*
Infants	—	1	1	2	—	2 *
Adults	5	1	6	5	3	8

* In one case duodenojejunostomy was performed.
In addition, *Case* 6—laparotomy and drainage of pancreas (died).

It may appear dangerous to divide the ring, if it is thickened by pancreatitis, or if there is no naturally occurring thin segment through which section may easily be performed.

In view of the usual position of the duct in the abnormal segment, and because the ring is usually at its weakest here, the best situation for division is anteriorly on the left side of the duodenum.

Pancreatic fistula is a danger of the procedure of division of the ring, and if the gland is fleshy and vascular Lehman (1942) recommends careful ligature of ducts and closure of the cut surface with interrupted sutures of fine silk. It is questionable if this is necessary, as experience with radical total gastrectomy suggests that all that is necessary is secure ligation of the whole divided segment with an unabsorbable material, such as silk or linen thread.

The numbers of cases reported are too small to allow firm conclusions to be drawn as to the best method of treatment.

In the earlier reported cases the results were definitely better with resection; but in the last, in 10 patients (1940–50), of 4 resection cases 2 died and 1 survivor had persistent symptoms, while all 6 short-circuit operations are reported as cured.

It is suggested, therefore, if for any reason division of the constricting ring appears at all difficult, gastrojejunostomy (or possibly partial gastrectomy) should be performed. A good result should be expected. If, however, the ring is relatively thin and avascular and easy of exposure, a direct attack on the obstruction by division of the ring of pancreatic tissue is the best method. This also gives satisfactory results.

SUMMARY

1. Annular pancreas is uncommon, and of the 58 documented cases only 18 have come to operation. Of the rest nearly all were silent and only found at post-mortem examination or in anatomical dissections.

2. Of the operation cases, 3 were in infants and 15 in adults.

3. The condition can easily be missed before, or even at, operation, and it is probable that the incidence is higher than the recorded number of cases suggests.

4. Gastrojejunostomy is probably the best method of treatment, but, if the ring is thin and easy of approach, division of the constriction ring may be performed instead.

5. With operation the prognosis is relatively good.

6. A twelfth successful operation is recorded.

We wish to record our thanks to Major-General D. Fettes, O.B.E.; Brigadier A. G. Harsant, O.B.E.; Colonel A. R. Oram, O.B.E., M.C., of the A.M.S.; to Group Captain G. A. M. Knight and Wing Commander Christopher Hardwick, of the R.A.F. Medical Branch, who saw the patient in consultation; to Major Hanson, late R.A.M.C., and Squadron Leader K. D. Forgan Morle, late R.A.F. Medical Branch, for their radiological help; and particularly Air Vice-Marshal Sir Stanford Cade, K.B.E., C.B. (late R.A.F. Medical Branch), for his helpful advice on treatment and diagnosis.

We are grateful to Miss Barbara Duckworth for the diagram of the condition found at operation.

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LEIOMYOSARCOMA OF THE PANCREAS

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CASE REPORT

THE patient was a man of 80 years who was referred from another hospital for supervision of his diabetes. He had had the latter for ten years and was controlled by dietary means until March, 1949, when he was started on P.Z.I. 10 units daily on an 1800 kg.-calories diet. At the end of 1948 he had noticed the appearance of small hard lumps under the skin of his trunk, and on examination at the hospital he was then attending, a large mass was found in the abdomen. Biopsy of one of the nodules in the skin was reported on as a ' typical neurofibroma '. In view of this, and the size of the mass in the abdomen, it was felt that the two were not causally connected.

He was seen in the Out-patients Department at Ashford Hospital on May 20, 1949, and on examination was found to be a thin, aged man who had obviously lost weight and was in poor general condition. He had evidence of emphysema and arteriosclerosis, and in the left hypochondrium was a hard, craggy mass. The liver was palpable to four fingerbreadths below the costal margin and was hard, nodular, and tender in places. Multiple firm mobile subcutaneous nodules were seen and felt on the trunk and upper arms and some of these were tender (*Fig.* 65). No enlarged lymph-nodes were

FIG. 65.—Drawing of patient to show distribution of nodules.

felt. His blood-sugar at the time was 370 mg./100 ml. He was admitted on May 25 for stabilization. Whilst an in-patient a biopsy was made of one of the skin nodules, and this showed the following appearances: it was rounded, 10 × 8 × 6 mm. in size, firm, and having a homogeneous white concave cut surface. Microscopically it showed fibrous tissue in which were numbers of spindle-shaped cells arranged for the most part in a disorderly manner but in places tending to be regimented. Many were elongated and there was a good deal of variation in size and shape, but no mitoses. It was thought to be possibly a neurilemmoma (*Fig.* 66), but a radiograph of the chest was reported as showing multiple shadows of neoplastic appearance, and the diagnosis appeared unlikely. The patient died shortly afterwards.

AUTOPSY FINDINGS.—

External Examination.—The body was that of a wasted aged male with a protruberant abdomen due to a palpable mass. Scattered throughout the skin of the thoracic and abdominal walls were firm nodules varying in size from 5 to 15 mm. diameter, being characterized

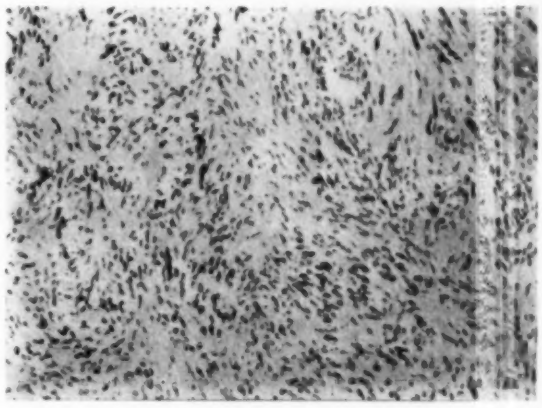

FIG. 66.—Photomicrograph of skin nodule (biopsy). (× 60.)

by exceeding mobility in all directions. One nodule larger than the rest, with a lobulated edge and less mobility, was present in the anterior axillary fold on the right. One or two nodules were also present in the skin of the back of the trunk, fronts of both thighs, and scalp.

Internal Examination.—

Skull: Some small tumour nodules present in the dura but none in the pia arachnoid or brain itself, although the choroid plexuses were studded with tumour deposits.

Skeleton: Multiple nodular metastases were found in all the bones examined, replacing marrow but causing no visible bony changes.

Mouth: Edentulous. No nodules in buccal cavity or pharynx, but one or two deep in the muscle of the tongue and outer coat of the œsophagus.

Neck structures: Some nodules in the thyroid gland, but no enlarged cervical lymph-nodes were seen.

Thorax: A little free fluid in the pleural cavities and a few easily broken down adhesions. Both lungs contained multiple white firm nodules throughout their substance, palpable and visible through the pleura. Characteristically, they slipped out of the way of the knife on cutting the lungs, and stood up above the surface. Their size varied from 2 mm. to 5 mm. diameter and they were freely mobile. No enlarged lymph-nodes were found. The pericardium was studded with minute nodules and one or two were seen in the coronary sinus and one in the wall of the left ventricle.

Abdomen: No free fluid in the peritoneal cavity but a few small nodules were seen in the parietal peritoneum. A large lobulated mass was seen arising retroperitoneally in the position of the pancreas and on dissection was found to be completely replacing it. The tumour was not attached to surrounding structures except by small adhesions, so that the transverse colon and omentum were lying across it anteriorly, and stomach and duodenum behind it, the latter in a groove in the mass

(*Fig.* 67). The latter showed several quite large cysts on the surface, due apparently to degenerative changes. The tumour weighed 3750 g. On cutting it, the tissue

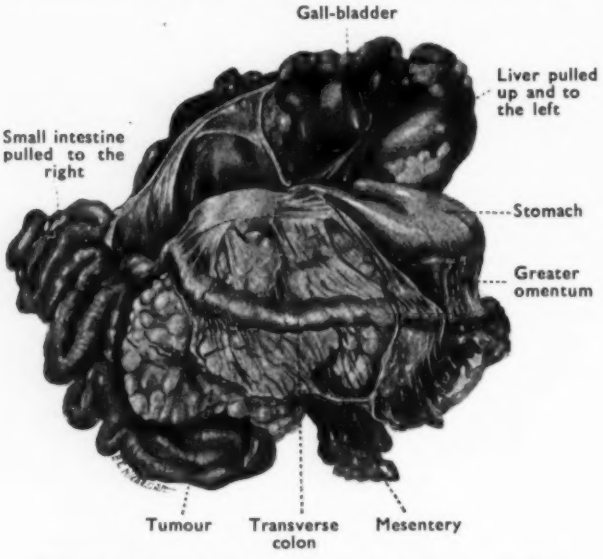

FIG. 67.—Drawing to show relations of tumour to other viscera.

was firm and yellowish with much fibrous tissue at the centre with areas of cystic degeneration and old hæmorrhages in places, but much softer at the periphery. The

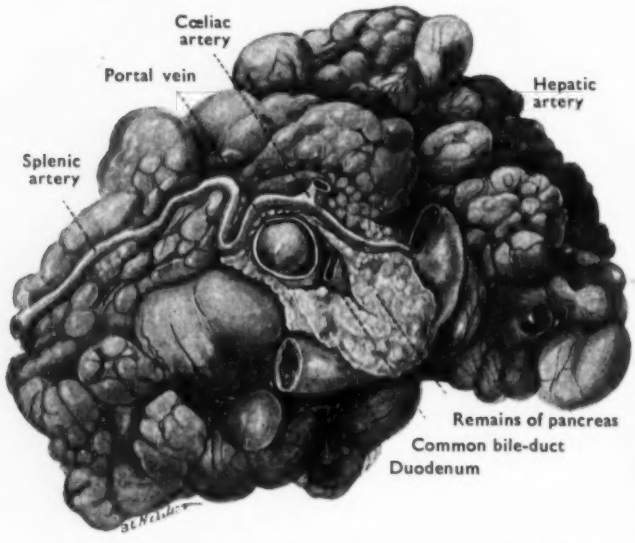

FIG. 68.—Drawing of tumour from above and behind to show relations to bile-ducts and portal vein and a nodule protruding into the latter.

mass was replacing the whole pancreas except for a small part representing the remains of the head, which, however, was full of nodules. A large nodule was growing into, but not blocking, the portal vein. The bile-ducts were not encroached upon and there was no obstruction to the flow of bile (*Figs.* 68, 69). The gall-bladder mucosa showed small nodules. The liver contained large masses of tumour deposit and weighed 3650 g. The left lobe was mainly one large tumour nodule 10 cm. in diameter. All the nodules had similar characters, viz., great firmness, paleness, and a definite suggestion of a whorled architecture superficially resembling uterine 'fibroids'. Some were umbilicated owing to central degeneration, showing cystic spaces with brown staining due to old hæmorrhage and also more recent bleeding. The spleen was normal in size and showed a few small nodules in a congested pulp. No enlarged lymph-nodes were found in the abdomen. Both adrenals contained small nodules in the cortex. The kidneys were normal, except for three or four minute nodules in the cortex and medulla. The bladder mucosa contained nodules. The prostate showed small nodules distinct from the nodular hyperplasia with which it was also affected. The testes showed small tumour deposits. The stomach showed multiple mobile nodules in the mucosa, some being umbilicated. Many were almost pedunculated whilst others were quite flat, varying in size from 5 mm. to 15 mm. diameter. The whole of the

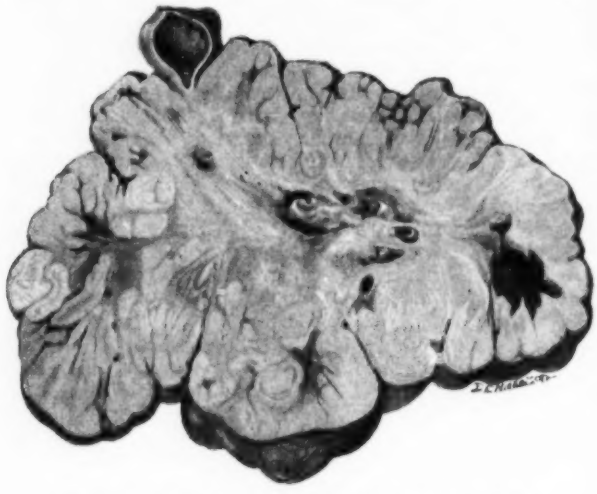

FIG. 69.—Drawing of a cut surface of the tumour.

small intestine also contained very mobile nodules mostly growing in the edges of the folds of mucosa. The large gut contained similar nodules to those in the rest of the alimentary tract.

HISTOLOGICAL APPEARANCES.—The tumour replacing the pancreas is a leiomyosarcoma which in the softer parts is very cellular but in the firmer parts shows much fibrous tissue. The cellular portion is well differentiated and consists of bands of plain muscle with supporting collagen, running in various directions (*Fig.* 70). The cells are mainly regular but there are a few mitoses (*Fig.* 71). In some places, however, there are bizarre and giant-nucleated forms (*Figs.* 72, 73). The metastases in liver (*Fig.* 74), gall-bladder, spleen, adrenal, thyroid, alimentary canal, tongue, prostate, testis, kidney, bladder, lungs, myocardium, voluntary muscle, choroid plexus, skin, subcutaneous tissues, and bone (*Fig.* 75) all show a similar structure to the various parts of the primary tumour. Some are, however, difficult to recognize as being of smooth-muscle origin, consisting merely of irregular elongated rather wavy spindle-shaped cells with little cytoplasm, occurring in bundles and whorls set in œdematous fibrous tissue (*Fig.* 76). The metastases are growing mainly by expansion and show very little infiltrative capacity, hence remaining well circumscribed. None of the lymph-nodes sectioned showed any growth.

DISCUSSION

Primary sarcoma of the pancreas, of whatever type, is very rare, and no case of leiomyosarcoma can be found in the literature, though it is possible that some have been published under the diagnosis of

spindle-cell sarcoma. Many of the cases reported as primary lymphosarcoma or round-cell sarcoma do not bear close criticism and several authors have suggested that only malignant connective-tissue tumours can be accepted with any degree of confidence as being truly of pancreatic origin (e.g., Mondor, Gauthier-Villars, and Sicard, 1933 ; Oesterlin and Blumenthal, 1935). Even benign connective-tissue tumours of the pancreas are rare. Chiari (1883) found 1 lipoma but no sarcoma of the pancreas in 10,000 consecutive autopsies. Out of 11,492 autopsies, Segrè (1888) found only 2 cases of sarcoma, and in neither case was it decided whether these were primary or secondary. Gruber (1929) found 1 myoma but no sarcoma in a series of over 20,300 autopsies. Itoiz (1946) says no cases were found in 11,000 autopsies performed at the Instituto Telémaco Susini in Buenos Aires.

The interesting points about the tumour described in this report are its association with diabetes

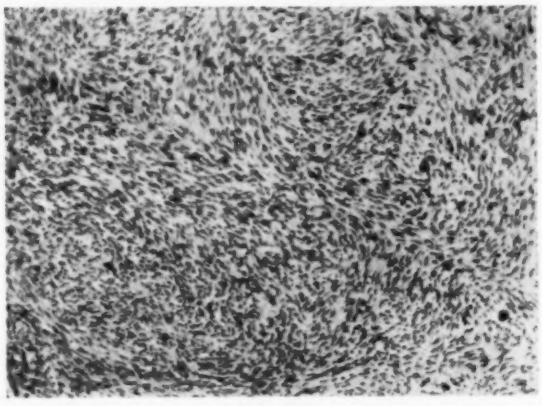

FIG. 70.—Photomicrograph of a cellular portion of the tumour. (× 60.)

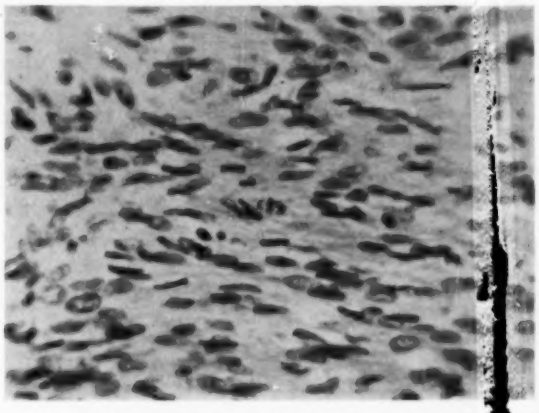

FIG. 71.—Higher power view of *Fig.* 70 (× 266·6), showing a mitotic figure in the centre.

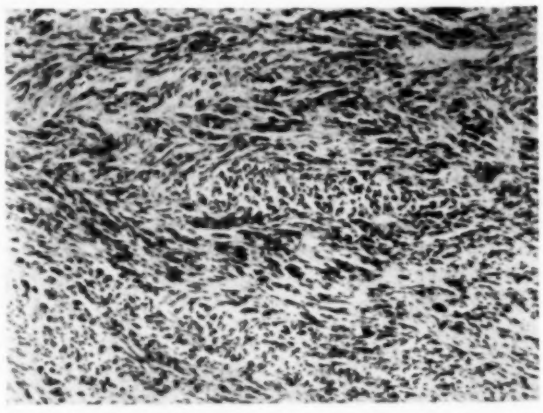

FIG. 72.—Photomicrograph of the tumour showing giant nuclei. (× 60.)

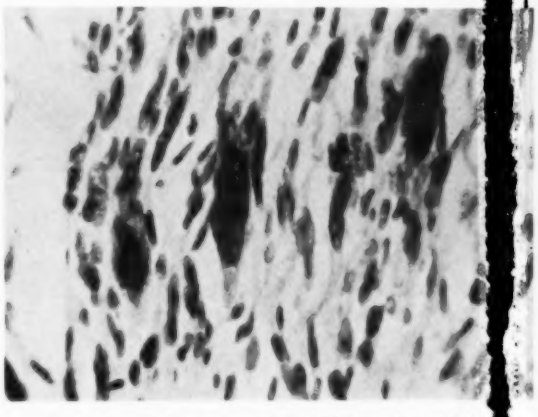

FIG. 73.—Higher power view of *Fig.* 72 (× 266·6).

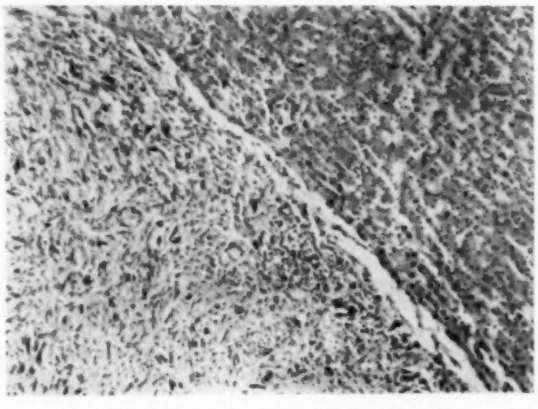

FIG. 74.—Photomicrograph of a metastasis in the liver (× 60) showing little infiltrative capacity.

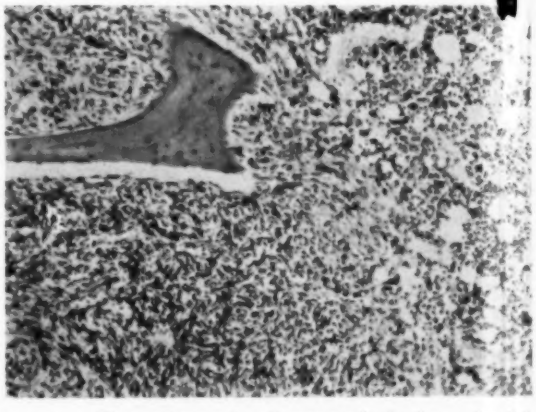

FIG. 75.—Photomicrograph of metastasis in bone (× 60). The edge of the nodule is not well defined in this situation.

mellitus, the widespread metastasis without lymph-node involvement and the resemblance of some of the secondaries (and indeed parts of the primary tumour) to neurilemmomata.

Diabetes mellitus only rarely follows tumours of the pancreas, the reason probably being that the patient usually dies from other effects of the growth

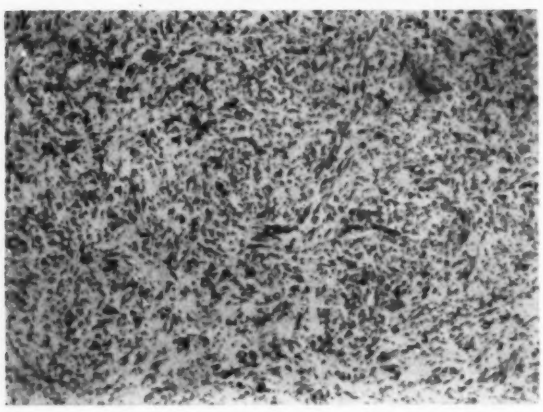

FIG. 76.—Photomicrograph of a less well-differentiated part of the tumour (× 60). This could be mistaken for a neurilemmoma.

(nearly always a carcinoma) before sufficient pancreas is destroyed to cause a deficiency in the islets. Carcinoma supervening on diabetes mellitus is not so rare, and since the advent of insulin may be expected to increase, as diabetics live longer. In the case under consideration, the diabetic history was of ten years' duration. It might be argued that the patient had idiopathic diabetes from the start and that the growth developed subsequently, but the size of the tumour, the amount of fibrosis, degeneration, cyst formation, and almost complete replacement of pancreas is very suggestive of its having been present a very long time and of slow growth. In common with most tumours, growth might be expected to be slow because of the age of the patient. He was 70 years old at the onset of the diabetes and it was ten years before skin nodules drew attention to the abdominal tumour. The size and amount of fibrous tissue in the hepatic metastases also suggest that these had been present some considerable time. Whether or not the tumour was a sarcoma from the beginning it is difficult to say. Possibly it might have been a simple leiomyoma which later became malignant. As for its origin, it would appear that the only source of plain muscle is the walls of pancreatic blood-vessels, since none exists elsewhere in the pancreas. This is in accord with one theory of the genesis of leiomyomata elsewhere (e.g., uterus).

In a paper on muscle tumours of the gastro-intestinal tract, Golden and Stout (1941) mention that these tumours can closely mimic neurilemmomata because of patchy necrosis and tendency to nuclear palisading, and it is interesting that this seems to apply to the neoplasm under discussion. Further, they state that relative avascularity leads to fibrosis, necrosis, cavity formation, hæmorrhages, cysts, etc., all of which are a feature of this pancreatic growth. An important difference, however, is that leiomyosarcomata of the gastro-intestinal tract rarely give rise to widespread metastases. Lymph-node deposits from primary malignant plain-muscle tumours, from whatever site, were never seen by them. This is the experience of most authors and is exemplified by the present case.

SUMMARY

A case of leiomyosarcoma of the pancreas in a man of 80 years with diabetes mellitus is described, which gave rise to widespread metastases in many organs with the exception of lymph-nodes.

My thanks are due to Dr. K. D. Keele for permission to use the case notes; to Miss B. E. Nicholson for the drawings; and to Mr. E. Targett, F.I.M.L.T., for the photomicrographs.

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OLIGODENDROGLIOMA WITH EXTRACRANIAL METASTASES

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METASTASES limited to the central nervous system from cerebral gliomata appear to be not uncommon. In one series comprising 22 consecutive necropsies of glioma cases, no less than 8 were found with such metastases (Cairns and Russell, 1931). These included all the common varieties of glioma, but they were most frequently associated with medulloblastomas. The oligodendroglioma was regarded as more benign in this respect, although Cairns (1929) described ependymal deposits in the occipital horns of the ventricles three years after the removal of a frontal oligodendroglioma. Greenfield and Robertson (1933) were the first to show that cerebrospinal metastases from oligodendroglioma may occur not only in the ventricles but also in the subarachnoid space, spreading by way of the cerebrospinal fluid. They considered this metastatic spread of oligodendrogliomas in the cerebrospinal pathways to be

very rare. Beck and Russell (1942), however, showed that it was not infrequent and described 4 cases in which diffuse subarachnoid spread occurred.

By contrast, extracranial metastases from gliomas are extremely rare, and even the few cases described are generally regarded with scepticism.

The subject has been reviewed in detail by Abbott and Love (1943), who analysed 16 cases of primary intracranial tumour which had been reported as having metastasized outside the central nervous system. Of these they regarded 6 cases as being unacceptable, and another 7 as being open to doubt, because histological proof of the primary tumour or the secondary deposits, or both, was not absolute. The cases rejected included the few cerebral gliomas which were thought to be associated with metastases, viz., that of Sachs, Rubinstein, and Ameson (1936—medulloblastoma of right cerebellar hemisphere with metastases over the sternum), that of Mittelbach (1935—glioblastoma of the left cerebral hemisphere with lung metastases), that of Loyal Davis (1928—spongioblastoma multiforme of the left cerebral hemisphere with metastases to the left axilla, the pectoral muscle, and the lung), and that of Nelson (1936—a cerebellar medulloblastoma with metastases to vertebral bodies).

Abbott and Love considered only 3 cases as definite examples of primary intracranial tumour with visceral metastases. These three were all malignant meningiomas, one described by Cushing and Eisenhardt (1938) and two by Russell and Sachs (1942). To these Abbott and Love added 1 case of their own, a frontal hæmangioblastoma which had invaded the superior longitudinal sinus and the skull with metastases to the lungs and hilar lymph-nodes. Since their review, reports have been made of a chromophobe-cell carcinoma of the pituitary with metastases to the liver (Kohlmeier, 1944), of a sarcomatous meningioma with metastases to cervical lymph-nodes (Globus, Levin, and Sheps, 1944), and of pineal tumours with metastases to the lungs (Tompkins, Haymaker, and Campbell, 1950). The question of metastasizing meningioma has recently been reviewed by Russell (1950), who finds at least 8 cases acceptable.

We have been unable to trace a single case of oligodendroglioma with extracerebral metastases, and for this reason this case report is presented.

CASE REPORT

A. R., a female aged 25, was seen on May 29, 1945, suffering from intermittent headache of three years' duration. Diplopia, giddiness, with weakness and clumsiness of the left hand, had been present for three months and were gradually increasing.

Clinical examination at that time indicated an intracranial space-occupying lesion with localizing features of a right-sided parietal tumour. There was severe papillœdema, spastic paresis of the left arm and left leg, astereognosis of the left hand, and loss of joint sense in the left leg.

In attempting ventriculography on June 5, a cystic tumour was encountered on the right side 5 cm. from the dura, exposed by the burr hole in the parieto-occipital region; 15 c.c. of spontaneously coagulating yellow fluid were withdrawn. Myodil injected into the cyst showed its site (*Fig.* 77). A right osteoplastic flap revealed a tumour which extended on the surface of the brain over an area 4 × 5 cm., reaching up to the midline and having an attachment to the falx just below the superior longitudinal sinus over an area 1·5 × 1·5 cm. in diameter. The tumour extended deeply into the hemisphere but appeared well demarcated from the surrounding brain. It was attached to dura mater in the region of the parietal eminence and this attached dura was removed with the tumour. Difficulty was encountered during the operation owing to the high intracranial pressure, and although the dural defect was repaired by pericranium the bone-flap was sacrificed because the hemisphere still tended to bulge.

The tumour weighed 80 g., and on section showed a central cavity with a little golden yellow fluid remaining.

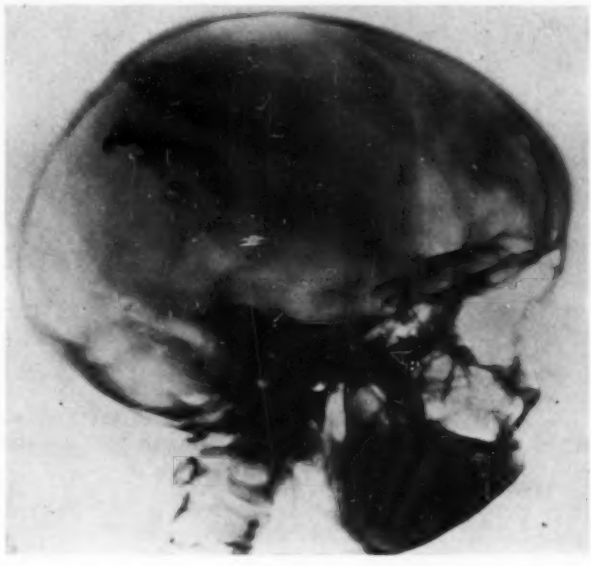

FIG. 77.—Myodil in tumour cavity.

Her recovery after operation was rapid. The flap remained tense for one week, necessitating daily lumbar punctures. The wound healed without infection.

Three weeks after the operation, apart from subsiding papillœdema, it was difficult to find any abnormal neurological signs. Performance of fine movements with the left hand was much improved and giddiness and diplopia had disappeared. There was slight weakness of the left foot.

HISTOLOGY OF THE TUMOUR.—A cellular growth with small areas of necrosis. The growth shows a distinctly alveolar pattern (*Fig.* 78) with capillary stroma and fine septa separating the small and large tumour cell units. The tumour cells are uniform. They are large and have an 'empty' clear cytoplasm and a central nucleus with a moderate content of chromatin. Not infrequently cytoplasm in the form of a spider's web is visible in the cell. Nuclear irregularities can be seen, i.e., variations in size and chromatin content, mitotic figures being moderately conspicuous. Conclusion: A cellular growth; elements not quite mature, suggesting the probability of local recurrence. Cells in histological detail and arrangements consistent with oligodendroglioma rather than secondary carcinoma.

SUBSEQUENT COURSE.—In the autumn of 1946 she was delivered of a healthy baby boy and continued well in every way until January, 1947, when she started to complain of suboccipital pain soon followed by vomiting, clumsiness of the left arm and leg, and numbness of the face and tongue on the left side. In February, the scalp flap began to bulge and papillœdema appeared. Lumbar puncture revealed cerebrospinal fluid under pressure with 3 cells (white cells) and 40 mg. of protein.

The youth and fortitude of this patient, her intelligent attitude towards her malady, and her concern over her child, were factors which led to a further attack on the tumour on May 29. The tumour was lightly adherent to the re-formed dura. It was soft, lobulated, and cystic in parts. A mass weighing 130 g. was removed. Its

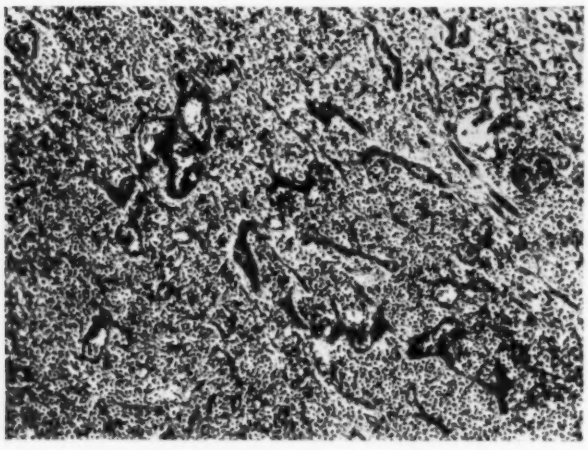

FIG. 78.—Brain, first biopsy (June 5, 1945). Cells with 'boxed' nuclei in alveolar arrangement. (× 80.)

median part extended to the superior longitudinal sinus and it was extremely vascular.

Recovery from the operation was uneventful, with a rapid recovery of power and sensation in the left arm and left leg.

HISTOLOGY (May 29, 1947) (*Fig.* 79).—The picture is in principle the same as that seen in the previous biopsy, but there is more extensive necrosis and some

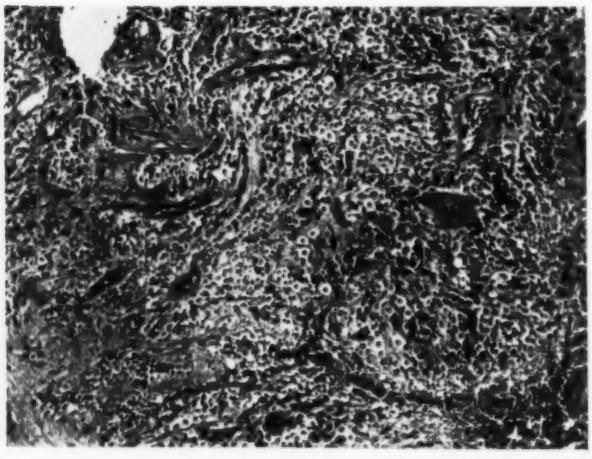

FIG. 80.—Brain, third biopsy (Feb. 19, 1948). A picture very similar to that shown in *Fig.* 78. Regular clear cells with 'boxed' nuclei predominant. There are also some of the smaller hyperchromatic cells. (× 90.)

parts are more cellular, showing a mixture of clear cells with smaller hyperchromatic and often spindly cells. The number of mitoses, however, is not impressive and apparently less than in the previous biopsy. The histological diagnosis was oligodendroglioma.

Operation was followed by a course of deep X-ray therapy. She remained very well until seven months later, when she noted a return of weakness of the left arm and left leg. The flap was bulging and headache returned.

Examination on Feb. 16, 1948, showed a tight scalp flap with a sound scar free of inflammation. The hair over the flap was very sparse owing to X-ray therapy. The abnormal neurological signs were similar to those found on her previous admissions, but in addition there was a complete left-sided homonymous hemianopia.

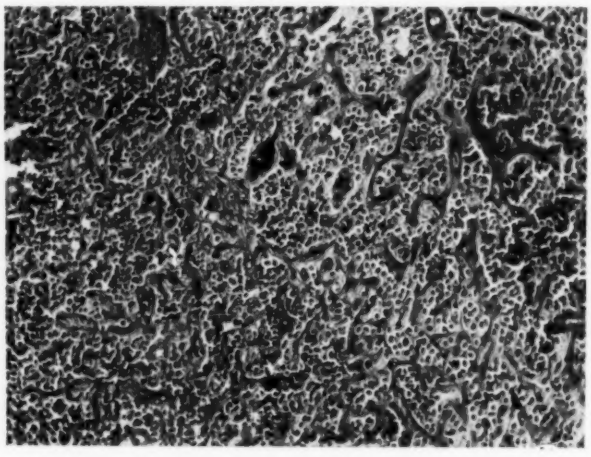

FIG. 79.—Brain, second biopsy (May 29, 1947). A picture similar to first biopsy as shown in *Fig.* 78, but in addition to regular cells with 'boxed' nuclei there are more 'cellular' parts with smaller and hyperchromatic elements. (× 90.)

Although operation was a forlorn hope, it was undertaken to relieve her headache and to allow her time to make arrangements for the future care of her child.

On Feb. 19 the previous flap was turned down. The tumour was found to be attached to the scalp in several places. There was extensive degeneration within

FIG. 81.—Tumour nodules in skin.

the tumour and no line of demarcation from the surrounding brain could be found. An extensive removal of tumour and surrounding brain was performed.

HISTOLOGY (*Fig.* 80).—Basically the same as before—oligodendroglioma—with fairly conspicuous mitoses and

small spindly hyperchromatic cells and extensive areas of necrosis.

Following this operation there was paresis of the left side which steadily improved over the next few months.

There followed an unexpectedly long interval in which she was symptom-free. In April, 1949, convulsive attacks affecting the left arm and left leg began, with a return of weakness of the whole of the left side, most marked after the convulsive attacks, which occurred about twice a week. She complained of occasional headache and her concentration was impaired, although she

FIG. 82.—Showing changes in the upper end of the right femur.

was able to keep her husband's files and correspondence efficiently. In July she was re-admitted on account of shortness of breath. Firm nodules were noticed in the scar of the scalp flap at this time (*Fig.* 81). The skin over them was thin and reddened. Lymph-nodes behind, in front, and below the right ear were found enlarged, and firm, but mobile. Pain in the region of the upper end of the right femur led to a radiograph of this area, which showed a great increase in density of the trochanteric region, the differentiation between cortex and medulla having been lost (*Fig.* 82).

Radiography of the chest showed consolidation of the whole of the basal portion of the left lower lobe (*Fig.* 83), with pleural effusion. Tomography showed patent bronchi leading into the consolidated lobe.

By September there was involvement of lymph-nodes of the upper cervical group (*Fig.* 84). A biopsy of one of these performed on October 4 showed :—

a. Regular and uniform large cells with clear cytoplasm and ' boxed ' nuclei predominating and arranged in an alveolar pattern (*Fig.* 85).

b. A picture indistinguishable from ' scirrhous carcinoma ', i.e., fibrous tissue infiltrated by strands of spindly

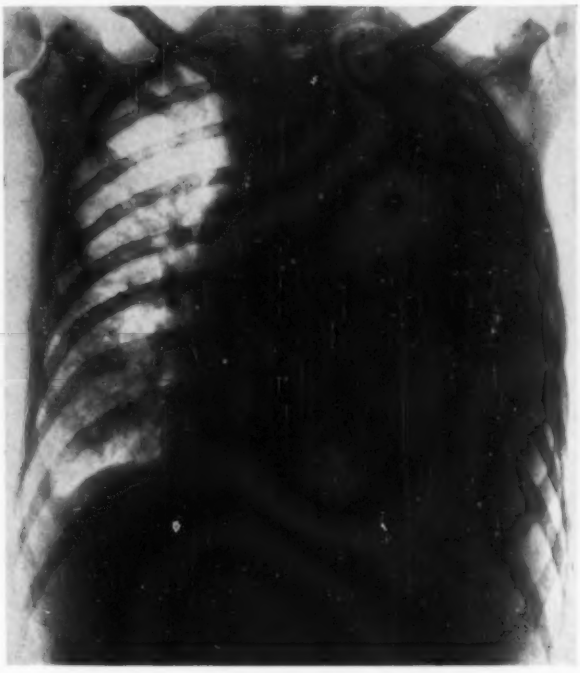

FIG. 83.—Left-sided pleural effusion and consolidation of left lower lobe.

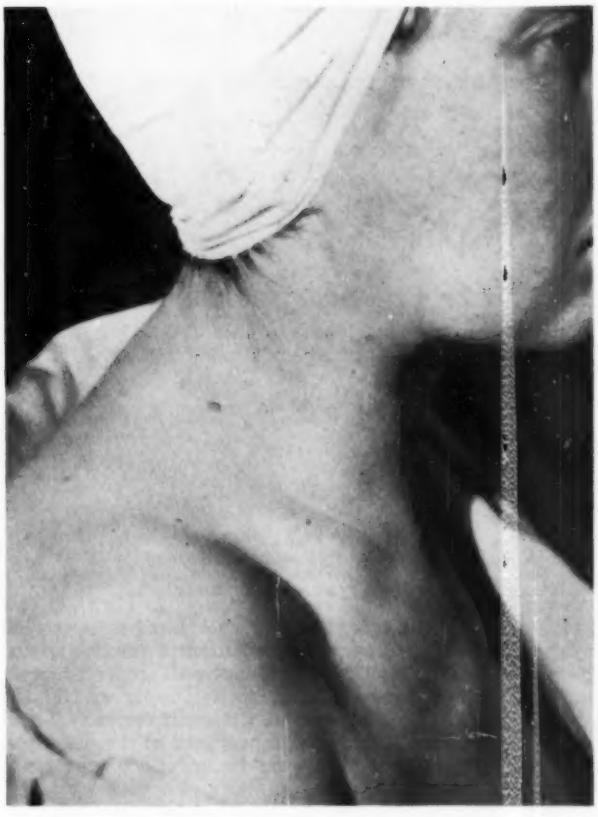

FIG. 84.—Enlargement of pre-auricular and upper cervical lymph-nodes.

hyperchromatic cells (*Figs.* 86, 87). Only a few clear cells with boxed nuclei can be seen.

c. Units showing a combination of the patterns described under (*a*) and (*b*) : In these the central areas consist of large ' clear ' cells with boxed hypochromatic nuclei.

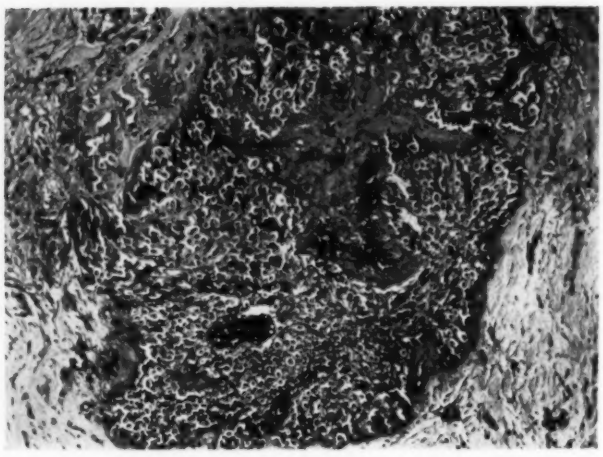

FIG. 85.—Lymph-node from neck (removed October 4, 1949). In the unit shown the clear cells with ' boxed ' nuclei predominate. There are small fringes of small hyperchromatic cells. (× 90.)

In the peripheral areas these are intimately mixed with the small hyperchromatic spindly cells.

The clinical course was now one of gradual deterioration, with the development of bilateral pleural effusion and increasing dyspnœa, and continued enlargement of the mass in the right femur. Combing the hair had resulted in abrasion of the thin skin covering the nodules

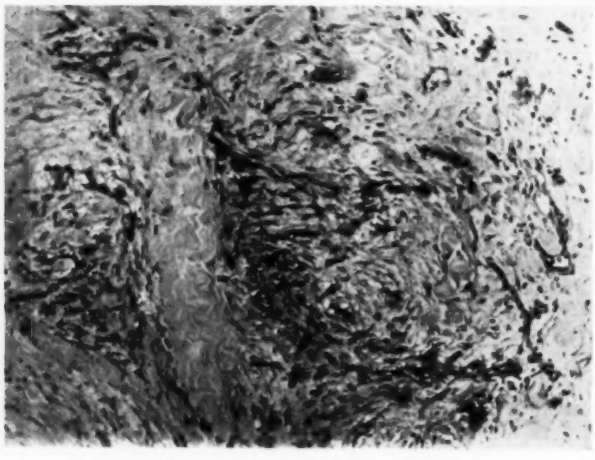

FIG. 86.—Lymph-node from neck (removed October 4, 1949). Picture of ' scirrhous carcinoma '. Infiltration of fibrous tissue by rows of spindly hyperchromatic cells. (× 90.)

of the scalp, with subsequent fungation of tumour tissue. X-ray examination on Nov. 26 showed further progress in the extent of bony sclerosis in the upper end of the shaft, the neck, and the head of the right femur. There was a shaggy dense spiculated appearance in the periosteal reaction now present along the inner side of the neck, lesser tuberosity, and shaft.

She died on December 3, *seven years after the onset of her first symptoms.*

A full necropsy was performed.

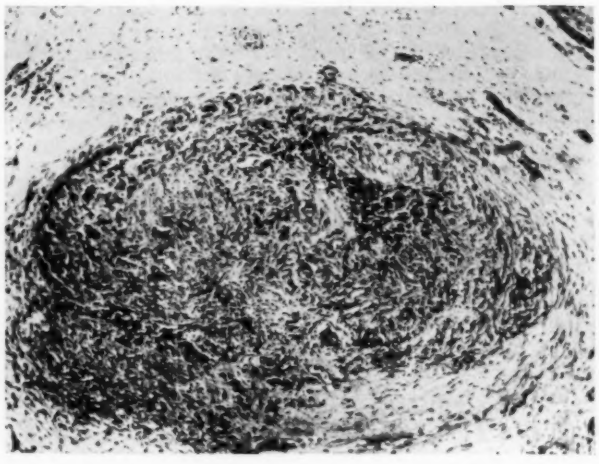

FIG. 87.—Lymph-node from neck. A unit in which spindly hyperchromatic cells predominate and only a few clear cells with ' boxed ' nuclei can be seen. (× 90.)

NECROPSY REPORT (December 4, 1949).—

Skull : A large growth 9 × 6 cm. in the right parieto-occipital area fungating through the skull defect (*Figs.* 88, 89). It was removed, together with a margin of

FIG. 88.—Surface of brain tumour.

FIG. 89.—Side view of brain tumour.

bone around it. The surface of the growth appeared to be necrotic and measured 5·5 × 5 cm. Attached to the posterior part of this main fungating tumour were two

additional nodules together 4 × 3 cm. The frontal pole of the main tumour had an additional nodule 1·5 cm. in

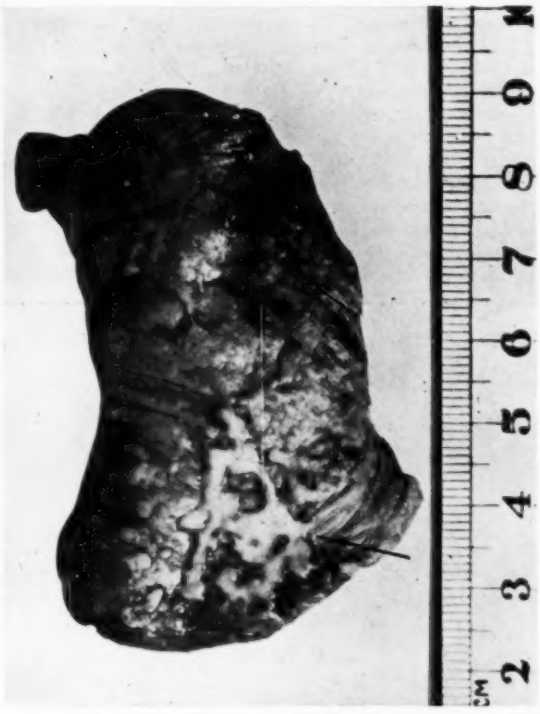

FIG. 90.—Left lung. Pleural surface with lymphangitic deposits of growth (arrow).

diameter. On cut surface the tumour was white and fairly solid, with a rubbery consistency. On horizontal section through the brain about 4 cm. deep the tumour

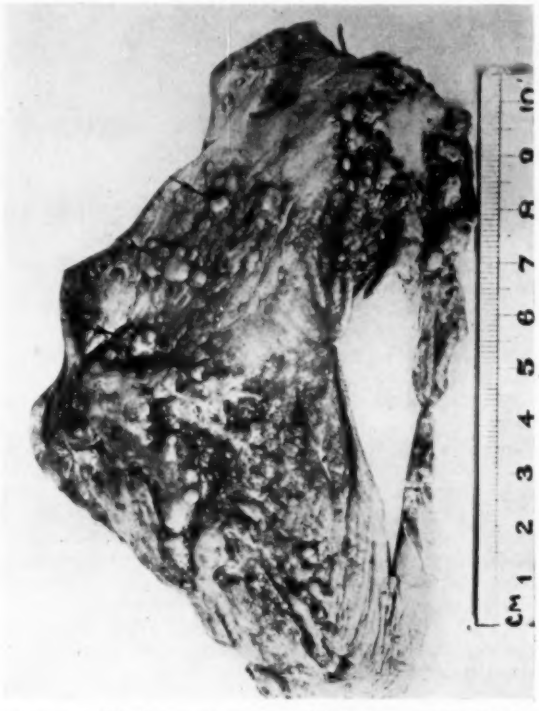

FIG. 91.—Diaphragmatic surface of left pleura with nodular deposits of growth (arrows).

area measured 4·5 × 7 cm. In this area there was a fistulous track 7 × 2 cm. lined by necrotic tumour material. Posteriorly this track terminated in the subdural space behind the fungating mass. Anteriorly it communicated with the posterior horn of the right lateral ventricle.

Lungs and Pleura: Several pints of straw-coloured fluid in the left pleural cavity and a smaller quantity of blood-stained fluid in the right. Multiple pleural

FIG. 92.—Survey of lung. One nodular deposit shown (left upper lobe—arrow). In addition there is thickening of the small bronchial and vascular branches throughout and infiltration of the bronchopulmonary and bifurcation lymph-nodes (two lower arrows).

secondaries, both parietal and visceral, and involving on the left side the seventh rib laterally (*Figs.* 90, 91). Detailed dissection of the bronchi failed to reveal any evidence of a primary growth. On cut surface the openings of the smaller branches of the vessels and bronchi appear to be accentuated and thickened, and there are fine strands connecting them with each other. (The picture is that of a 'lymphangitis carcinomatosa'.) The lung parenchyma was infiltrated by nodular deposits (*Fig.* 92) which become confluent in the left lower lobe. Hilar lymph-nodes enlarged and obviously infiltrated by growth (*Fig.* 92).

Right Femur: Head and neck extensively replaced by dense osteoplastic growth (*Fig.* 93).

Breasts: Some fibrosis, more marked on the left side. No evidence of growth.

A group of right deep *cervical lymph-nodes* moderately enlarged and inflated with fairly hard froth was seen.

Thyroid: Fleshy, no evidence of carcinoma.

Heart and Blood-vessels, *Stomach*, *Intestines*, *Liver*, *Spleen*, *Kidneys*, *Pancreas*, and *Suprarenals*: No appreciable change.

Lumbar Vertebræ: No macroscopical evidence of secondaries.

Left Femur: Normal.

POST-MORTEM HISTOLOGY.—

1. *Brain Tumour* (superficial parts with adherent skin).—The tumour is largely necrotic and pervaded by

polymorphonuclears. In the depth it is separated from the brain tissue by a very vascular zone almost like granulation tissue. The tumour-cell islets show mostly mature

FIG. 93.—Head and neck of right femur. Dense osteoplastic growth.

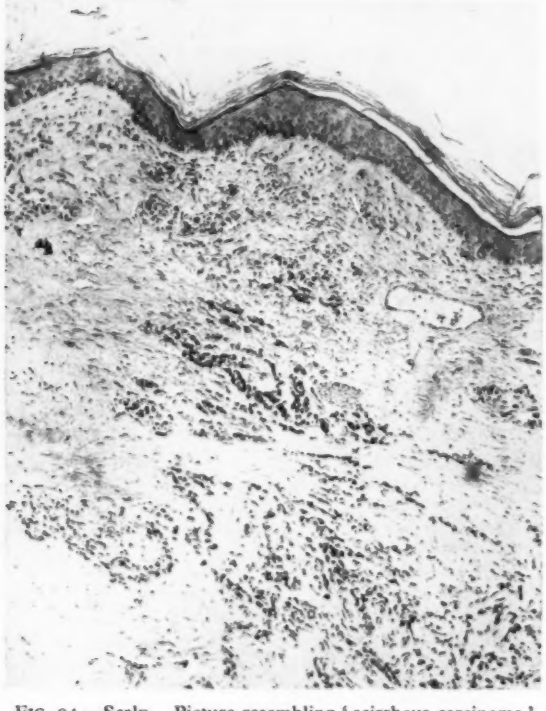

FIG. 94.—Scalp. Picture resembling 'scirrhous carcinoma'. (× 120.)

clear cells with 'boxed' nuclei. Pyknotic nuclei and others that are larger and more hyperchromatic than the average, are found where the tumour-cell islets border on necrotic areas. In some areas the tumour cells are spindly and hyperchromatic, arranged in parallel rows separated from each other by numerous congested vessels. Towards the periphery they recover the ordinary configuration and size. The deposits extend into the cutis, as small tongues or irregular small areas of typical clear cells, often in a perivascular (lymphangitic) pattern.

2. *Brain tumour* (deep, mostly necrotic, parts, bordering on ventricle).—Most of the tissue is necrotic, full of hæmorrhages and thromboses of large and small vessels. The small areas in which tumour deposits can be seen show mostly pyknotic cells and nuclei.

3. *Scalp with Fungating Growth.*—The deeper layer of the cutis shows a picture not unlike scirrhous carcinoma, the cells being small and hyperchromatic (*Fig.* 94). The stroma is œdematous and mucoid. In more

FIG. 95.—Skin of scalp. Units consisting of 'clear' cells with 'boxed' nuclei. (× 66·6.)

peripheral areas small nodular units are found in which the cells conform to the typical clear elements with 'boxed' nuclei (*Fig.* 95). Some of these nodules are necrotic in the centre, and others show an intimate mixture of the large clear cells with the small hyperchromatic cells, as seen in the more superficial layers.

After formalin fixation, the following parts were processed according to Hortega's method (Penfield's modification) for glia cells (for details of technique, *see* Russell, 1939):

a. Brain tumour fungating through the skin: The tumour-cell deposits contain a fair number of cells with black argentaffine rim and one or a few delicate processes, the latter branching and occasionally showing 'varicose' swelling.

b. Brain tumour from the depth: mostly necrotic. In nodules bordering necrotic areas, some apparently degenerating glial elements are seen—showing fairly large cell bodies with black rim, some with fine argyrophile processes. No argentaffine elements seen in the frankly necrotic areas.

Reticulin preparations (after Wilder) failed to show any argentaffine fibres in the actual units of growth, while such fibres showed up well in the vascular adventitia.

4. *Lung*.—Lymphatic spread in the subpleural areas (*Fig*. 96) and the sheaths of small vessels (*Fig*. 97). Units of growth are composed of 'clear' cells often mixed with small hyperchromatic cells.

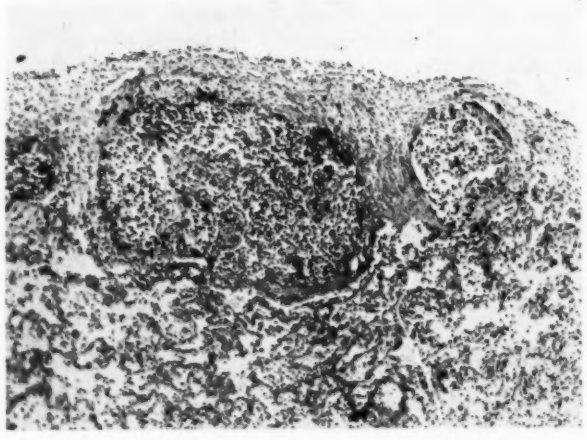

FIG. 96.—Lung. Lymphangitic spread subpleurally. Units composed chiefly of large 'clear' cells. (× 50.)

5. *Hilar Lymph-nodes*.—These are almost completely replaced by growth. The latter is largely necrotic, with peripheral parts consisting of units of large clear cells.

In some of these units there are pleomorphic and somewhat anaplastic cells (*Fig*. 98). Apart from these, the stroma occasionally contains lymphocytes, eosinophils, and even an occasional foreign-body giant cell of the Langhans type.

Hortega-Penfield sections (*Figs*. 99, 100) show argentaffine cells similar to those seen in the brain tumour.

Reticulin preparations had the same negative result as those of the brain tumour, reticulin fibres showing up

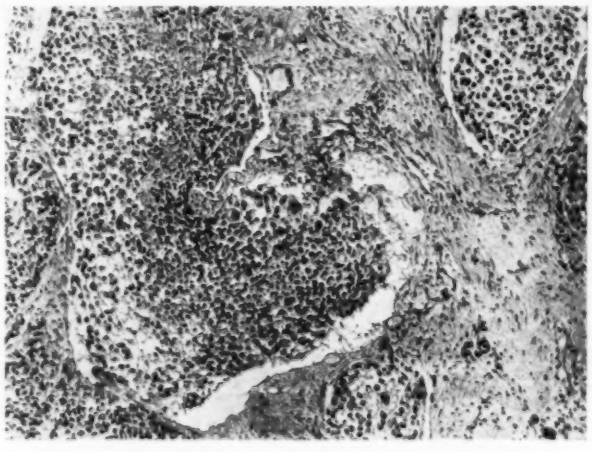

FIG. 98.—Hilar lymph-node. Mixture of large 'clear' cells with somewhat anaplastic cells in the periphery. (× 90.)

in the vascular adventitia, being absent in the actual tumour-cell units (*Fig*. 101).

6. *Femur*.—Marrow spaces replaced by extensive deposits of clear cells (*Fig*. 102).

7. *Kidney*.—Congested, with occasional collections of lymphocytes in the slightly thickened and œdematous stroma. A small area consisting of large cells with 'boxed' nuclei could be seen in the cortical stroma in one place.

8. *Breast*.—Step-sections taken through both breasts show some fibrosis, but no evidence of growth.

9. *Liver, Spleen, Stomach, Suprarenals, Myocardium, Thyroid, Pituitary*.—No appreciable change.

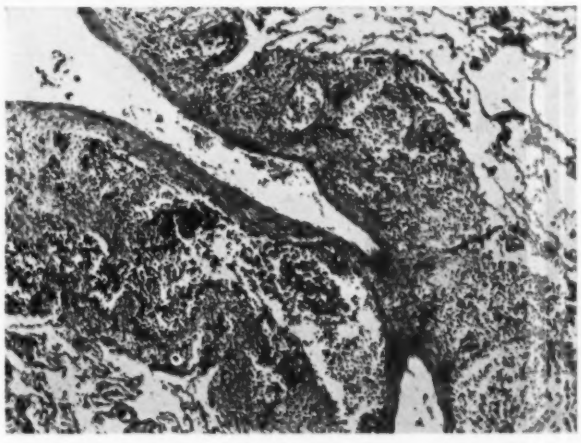

FIG. 97.—Lymphangitic spread in vascular sheath inside lung. (× 50.)

Morbid-anatomical and Histological Summary.—The anatomical evidence for this case is based on: (1) Three biopsy examinations of the

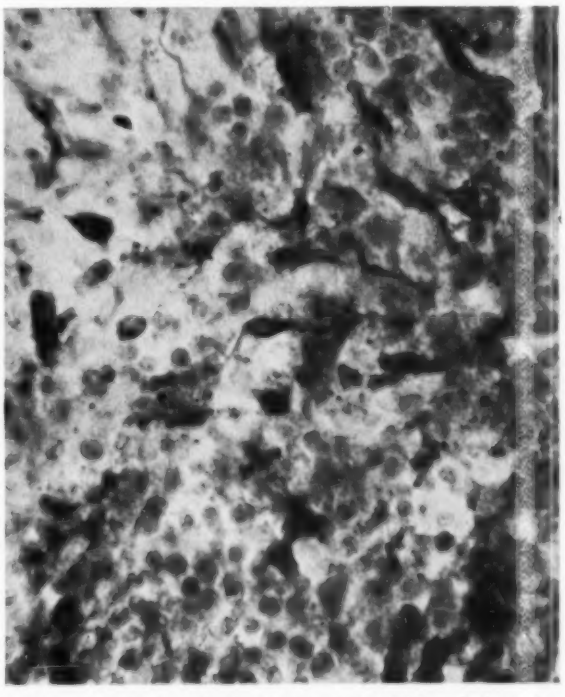

FIG. 99.—Hilar lymph-gland (Hortega-Penfield). Cells with black (argentaffine) rim with fine polar processes. (× 470.)

brain tumour extending over a period of five years, and taken at intervals of one to two years. (2) One biopsy examination of a cervical lymph-node which developed three months before death. (3) The post-mortem examination.

1. The biopsy material of the brain tumour reveals the structures usually diagnosed as oligodendroglioma. The tumour cells are the typical

large cells with clear cytoplasm and central ' boxed '-looking nuclei, arranged in a monotonous regular alveolar pattern. Some mitotic figures could be seen,

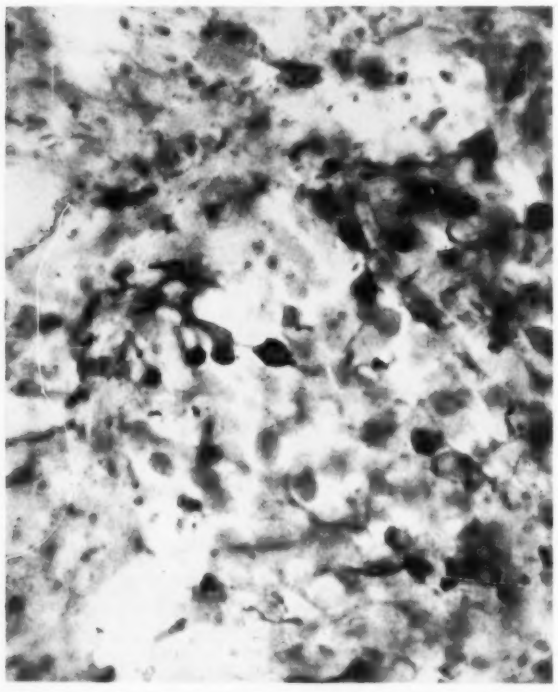

FIG. 100.—The same as *Fig.* 95. Another area. (× 470.)

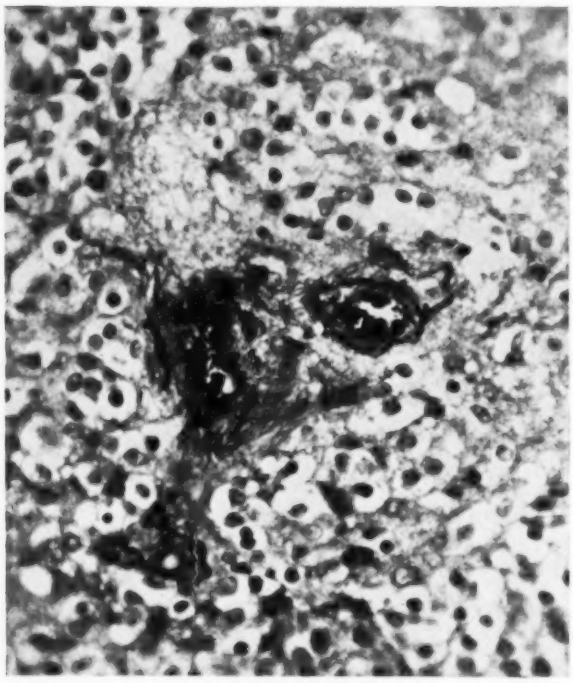

FIG. 101.—Hilar lymph-node. Wilder's preparation for reticulin fibres. These are plainly seen in the vascular adventitia, but absent in the tumour cell units. (× 435.)

and in the second biopsy an admixture of immature-looking small hyperchromatic cells was noted. On the whole, however, the typical structures of oligodendroglioma recurred with fair consistence.

2. The same basic pattern is seen in the cervical lymph-node. The units of large cells with ' boxed ' nuclei show marginal areas with small hyperchromatic and immature-looking cells, identical with those described in the second biopsy of the brain tumour. The latter cells occasionally form units by themselves which are indistinguishable from scirrhous carcinoma.

3. The histological organ changes are marked out by the singular consistence of the basic pattern, which conforms to the structure of the brain tumour as seen

FIG. 102.—Right femur. Marrow space replaced by extensive deposit of clear cells with ' boxed ' nuclei. (× 133.)

in the biopsy and necropsy material. The tumour progresses by lymphatic extension, notably in the lung, which presents the classical appearances of ' lymphangitis carcinomatosa '.

In the brain tumour as well as in the deposits in the lungs, cells could be demonstrated with argentaffine rims and processes as seen in oligodendroglioma. No such cells could be discovered in numerous sections treated with the same method and at the same time from two cases of bronchial carcinoma chosen at random. On the other hand, the suspicion that we might be dealing with a systemic growth such as reticulosarcoma was negatived by the failure to demonstrate any argentaffine fibres in connexion with the tumour cells in reticulin preparations.

The main features of these observations are, therefore: (*a*) the singular clinical course; (*b*) the consistence in the histological pattern of all manifestations of the growth observed for five years; and (*c*) the demonstration by the Hortega method of

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elements similar to those commonly seen in oligodendroglioma, in the absence of any evidence of reticulin formation by the tumour cells.

All these features appear to favour the interpretation of the growth as a primary tumour of the brain and its termination by multiple remote metastases. It should be emphasized that gross invasion of the scalp by the tumour had obviously been instrumental in bringing about lymphatic and blood-borne generalization, the first remote site of growth coming to clinical attention being the upper cervical group of lymph-nodes.

SUMMARY

1. A brain tumour with a seven-year history followed up clinically and by biopsies, terminated with general extracranial metastases.

2. The histological picture of oligodendroglioma remained constant through all biopsies and extracranial metastases.

3. By the Hortega method elements similar to those commonly seen in oligodendroglioma were demonstrated in the brain tumour and extracranial metastases, in the absence of any evidence of reticulin formation by the tumour cells.

The authors are greatly indebted to Professor D. S. Russell for advice and criticism in the histological examinations and the presentation of these observations. They also wish to thank Mr. L. G. Spain for technical assistance, and Mrs. B. Burnett and Mr. A. G. Booker for the photographic work.

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THE USE OF A MODIFIED MILLER-ABBOTT TUBE IN THE TREATMENT OF DUODENAL FISTULA

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THE purpose of this paper is to describe a new conservative treatment of duodenal fistula. Owing to the rarity of the condition the opportunity has arisen to treat only two cases, but the method used proved so promising in what is usually a most lethal condition that it was considered justified to publish this report.

The generally accepted classification of duodenal fistulæ is: (1) Internal duodenal fistula communicating with some other hollow viscus; (2) External duodenal fistula opening on the body surface. In addition the fistula is 'lateral' when it arises from the otherwise intact duodenum, or 'terminal' when it originates from the blind duodenal stump following Polya gastrectomy. This latter type of fistula is not amenable to the treatment about to be described.

Causes of External Duodenal Fistulæ.—Analysis of 96 cases, most of which were collected from the literature by Kittleson (1933), shows that operations on the biliary tract accounted for 23; perforated duodenal ulcer for 22; operations on the duodenum for 15; right nephrectomy for 11; partial gastrectomy for carcinoma for 10 (some of these being 'terminal' duodenal fistulæ); traumatic rupture of the duodenum for 6; acute appendicitis for 4; other causes for 5.

There is little doubt that nowadays, owing to the popularity of the Polya gastrectomy for duodenal ulcer, 'terminal' duodenal fistulæ are much more common than these figures suggest.

Review of Treatments.—The two main local factors which militate against the spontaneous closure of the fistula are the powerful tryptic action of the juice and the normal high intraduodenal pressure, which varies from 10 to 15 cm. of H_2O, and rises to between 30 cm. and 75 cm., or occasionally even as high as 140 cm. H_2O, during the frequent duodenal contractions (Brody and Quigley, 1947). Treatment therefore has rightly been directed against these factors, but the variety of methods that have been described indicates the unsatisfactory nature of the results.

Operative Treatments.—In all but the smallest duodenal fistulæ the general condition of the patient is poor, and operative interference is hazardous. The main surgical procedures applicable in various cases are as follows:—

1. Direct Suture: This is unsatisfactory in all but very early fistulæ and small chronic fistulæ, because of the friability of the tissues.

2. Direct Suture and Gastrojejunostomy: The latter is of dubious value because the short circuit is

incomplete unless pyloric or duodenal obstruction is present. Moreover, Maingot (1948) states that the fatality is greater than in suture alone.

3. Direct Suture, Pyloric Occlusion, and Gastro-jejunostomy: This operation is probably unsound for it mimics the Polya type of gastrectomy, of which the chief and most dreaded complication is duodenal fistula. In any case Colp (1923) showed that it is too severe: only 1 of the 7 patients so treated survived.

4. Jejunostomy: The advantage of this operation is that it allows the fistula-juice to be reintroduced into the jejunum. It may be essential in cases where a feeding tube cannot be made to pass through the stomach and past the fistula.

Conservative Treatments.—Spontaneous closure of the fistula is more likely to occur if the fluid escape

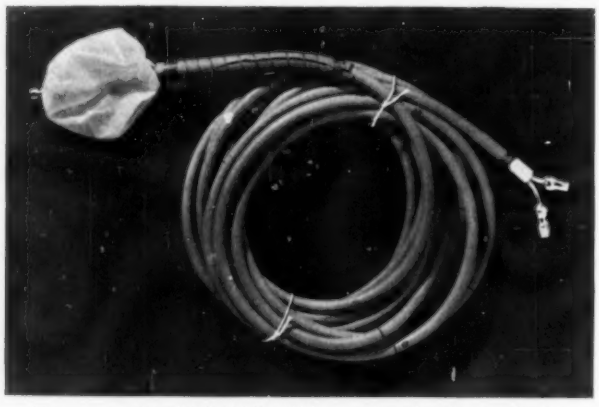

FIG. 103.—Modified Miller-Abbott tube showing occlusion, by split rubber tubing, of the holes proximal to the balloon.

can be reduced; with this object most surgeons withhold fluid by mouth, and some also employ continuous intraduodenal suction by duodenal tube; the administration of atropine and ephedrine in order to reduce pancreatic and duodenal secretion has even been suggested. The importance of reducing the intraduodenal pressure was stressed by Perl (1935), who employed both a duodenal suction tube and a jejunal feeding tube.

There has been no report of the successful use of an external obturator to occlude the fistula, nor have I been able to find any record of the use of an entirely internal obturator.

In order to reduce the tryptic action of the juice, Ochsner (1928) recommended that the patient should be given egg-white by mouth; but local applications of horse serum or aluminium paste, or irrigations with hydrochloric acid or peptone, have been more generally used.

More effective than attempts at mere neutralization of the proteolytic enzymes is the rapid removal of fluid from the fistula by a suction tube introduced into it (Erdman, 1921). Not only does this minimize tissue digestion in the fistula itself, but it also prevents local skin digestion and bed-sores caused by leakage of juice into the bed. Septic absorption from bed-sores was at one time a potent cause of death.

Maintenance of electrolyte and fluid balance is essential; Einhorn (1920) accomplished this by collecting the fistula juice by a suction tube in the fistula, as described above, and reintroducing it down a jejunal feeding tube. These procedures are nowadays augmented when necessary by intravenous fluid therapy. As mentioned previously, if a jejunal feeding tube cannot be passed, jejunostomy may be necessary.

Prognosis.—The fatality rate from duodenal fistula is greater than from fistulæ elsewhere in the intestine. Large duodenal fistulæ are very lethal, but small ones carry a relatively good prognosis (Colp, 1923). Impressions from most published figures are probably misleading since many unsuccessful cases are not published. Kittleson (1933) gives a fatality rate of conservative treatment in 65 cases collected from the literature as 28 per cent, and the fatality rate in a further 30 cases treated by operation as 50 per cent. Schneider (1944), however, in reviewing a consecutive series of 33 cases occurring in the Charity Hospital, New Orleans, between 1906 and 1942, gave the fatality as about 50 per cent whether they were treated conservatively or by operation.

The size of the fistula is stated in very few of the recorded cases, and doubtless these series include many small fistulæ which in any case carry a good prognosis. Some of them were probably not true duodenal fistulæ, but biliary fistulæ associated with an incompetent ampulla of Vater. This would have allowed duodenal contents to regurgitate up the common bile-duct, as is illustrated by the following case.

Case M. L. (R.I. No. 42388/45).—A woman, aged 66, suffering from cholelithiasis, underwent cholecystectomy and exploration of the common bile-duct on May 28, 1948, by Mr. G. E. Moloney. The ampulla of Vater was dilated up to the size of a 10 English gum elastic bougie, and subsequently the common duct was repaired without drainage of its lumen. The duodenum appeared normal, as it had been previously on radiography after a barium meal.

Some days after operation she began to drain bile-stained food from the wound at the rate of 6 oz. (180 ml.) a day. Oral methylene blue, which is excreted in bile only in a colourless form, appeared coloured in the fistula after 8 hours. Radiography after a barium meal did not show the site of leakage from the duodenum, and lipiodol introduced into the external fistula did not enter the bowel.

The patient was treated by continuous suction both from the stomach and from the fistula, and she was fed by a modified Miller-Abbott tube passed into the jejunum. Drainage from the fistula continued for ten days at a uniform rate of 6 oz. (180 ml.) per day, but at the end of this time the fluid consisted of pure bile. It was then obvious that the internal opening of her fistula was in the biliary tree and not in the duodenum as had been suspected. On the twenty-first day after operation the fistula was healed.

THE TREATMENT OF DUODENAL FISTULA BY MODIFIED MILLER-ABBOTT TUBE

The method now described was employed in the 2 cases of duodenal fistula reported later in this paper.

Principle.—The balloon of a Miller-Abbott tube is used to block the fistula internally, while nutrient fluid is fed through what is normally the suction channel of the tube so as to emerge distal to

the balloon. Since this channel has apertures both proximal and distal to the balloon, the proximal ones are closed by a piece of split rubber tubing bound over them with Chinese twist silk. (*Fig.* 103).*

The stomach is kept empty by continuous aspiration through a Ryle's tube.

Aluminium paste is used to prevent excoriation of the skin around the fistula by the digestive enzymes, and continuous aspiration is carried out through a tube inserted for approximately 2 in. (5 cm.) into the fistula. In addition it is likely that the nutrient fluid has some effect in neutralizing the enzymes (Ochsner, 1928).

Application of the Method.—When a duodenal fistula is suspected methylene blue should be given by mouth; its appearance in the fistula helps to confirm the diagnosis.

The patient is then taken to the X-ray Department, where radiography after a barium meal shows the exact site of the fistula. A Miller-Abbott tube, modified as described, is passed through the nose and guided into the pyloric antrum under screen control: this usually succeeds if the head of the table is tilted up about 40°, and if the patient is laid on his right side and rolled from the semi-supine to the semi-prone position. Once the tube is in the pyloric antrum its further passage is certain and the patient is returned to the ward. When radiography by portable machine shows the tube to be in the small intestine the patient is returned to the X-ray Department. Under screen control, the tube is gently withdrawn until the balloon is opposite the fistula; the tube is then firmly strapped to the nose and 15 ml. (0·5 oz.) of water is introduced into the balloon. If more than 15 ml. is introduced the duodenal peristaltic waves have been found to grip and dislodge the balloon.

Continuous stomach aspiration with a Ryle's tube inserted through the other nostril is begun and continuous feeding down the Miller-Abbott tube is now started. The nutrient fluid must be thin; citrated milk or a mixture of half-and-half citrated milk and 2·5 per cent glucose in 0·25 normal saline, with one yolk of egg per pint (600 ml.), proves satisfactory. Egg-white is unsatisfactory as it tends to block the tube. At this stage in the procedure drainage from the fistula should decrease considerably.

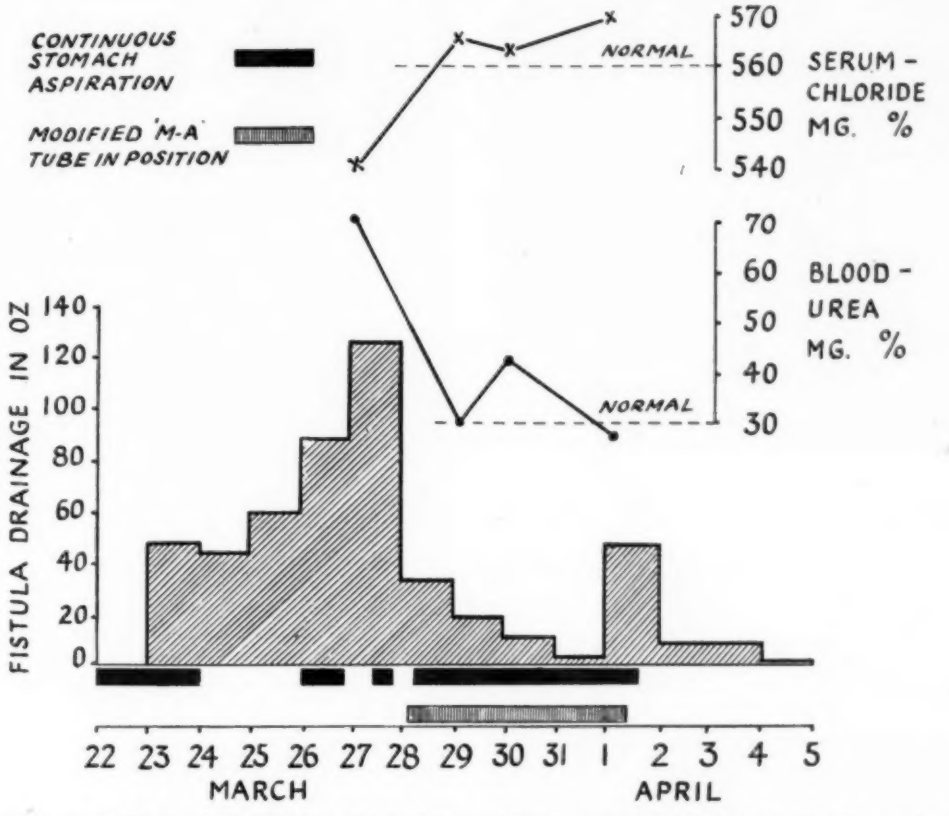

FIG. 104.—*Case* 1. Graph showing the effect on fistula drainage, blood-urea and blood-chloride levels of stomach aspiration alone and of stomach aspiration combined with the use of the modified Miller-Abbott tube.

CASE REPORTS

Case 1.—R.I. No. 11285/43.

A. S., a mechanic aged 40, was admitted as an emergency to a medical ward under Dr. Hobson on Feb. 17, 1948, suffering from acute cholecystitis with jaundice. His symptoms dated back for fifteen years; but a cholecystogram five years before admission had been normal, though at that time he was found to have essential hypertension with a blood-pressure of 200/130. Four days before admission severe pain, worse on breathing, started in the right hypochondrium.

* Miller-Abbott tubes with no holes proximal to the balloon can now be supplied by Wm. Warne & Co., of Barking.

ON EXAMINATION.—There was slight jaundice (bilirubin 3·4 mg.) and he was tender, with 'guarding', in the right hypochondrium.

PROGRESS.—During the next four weeks the abdominal tenderness subsided and the jaundice disappeared, but on four occasions there was an evening pyrexia of 100°–101°. Cholecystography showed no filling of the gall-bladder.

OPERATION (March 19).—After three days of penicillin therapy Mr. Elliot Smith exposed the gall-bladder

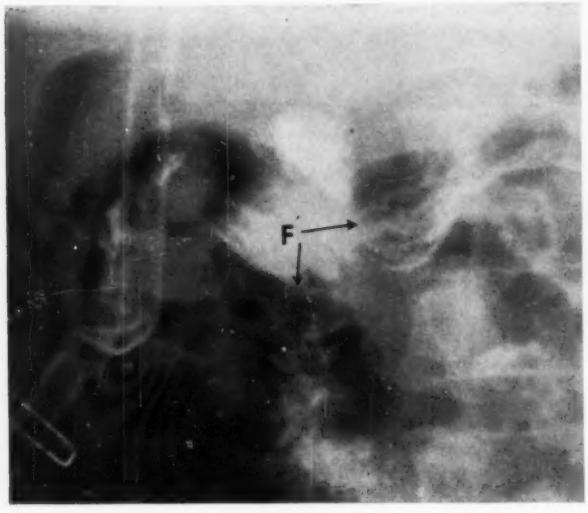

FIG. 105.—Barium-meal radiograph of *Case* 1 showing the barium tracking from the duodenum towards the drainage-tube. F, Fistulous opening in duodenum.

region through an upper paramedian split rectus incision and found an empyema of the gall-bladder with very vascular omental adhesions. Hartman's pouch was adherent to the duodenum, and together they formed the walls of an abscess which disgorged pus and a smooth black stone. Cholecystectomy was performed with difficulty, but the duodenum appeared to be intact. A tube drain was inserted down to the gall-bladder bed.

POST-OPERATIVE PROGRESS.—The patient's condition was at first good, but there was a profuse purulent discharge from the drainage-tube. He was given 30,000 units of penicillin every three hours, and 1 g. of sulphamezathine every four hours.

On the second post-operative day vomiting persisted and hourly stomach aspiration and intravenous fluid therapy were started. In spite of the aspiration, discharge from the drainage-tube increased to 58 oz. (1650 ml.) during the fourth day. Methylene blue given by mouth appeared in the discharge in four and a half hours, and it was obvious that a duodenal fistula had developed. By the eighth day the drainage had increased to 126 oz. (3580 ml.) (*Fig.* 104). Radiography after a barium meal now showed a large fistula leading from the outer aspect of the junction of first and second parts of the duodenum (*Fig.* 105). The modified Miller-Abbott tube was therefore put into operation as previously described. It is shown in position in *Fig.* 106. Drainage from the fistula decreased immediately to 34 oz. (965 ml.) in the twenty-four hours. Three days later the drainage was only 2 oz. (57 ml.), and the blood-chlorides, which had been subnormal, returned to normal.

Unfortunately at this stage the tube became blocked, owing to administration of unsuitable fluid containing egg-white and flour. The tube was therefore withdrawn, and fistula drainage increased to 48 oz. (1368 ml.) during the next twenty-four hours, but subsequently decreased spontaneously, ceasing altogether three days later.

The patient was discharged to a convalescent home on April 9, the twenty-first post-operative day, and five days after his fistula had ceased to discharge.

Case 2.—R.I. No. 107753.

J. J., male aged 69, a retired coal merchant, was admitted on June 23, 1949, suffering from a perforated duodenal ulcer of eight and a half hours' duration. He had a long history of dyspepsia which had been worse in the last three days. Eight and a half hours before

FIG. 106.—*Case* 1. The balloon of the modified Miller-Abbott tube is in position at the junction of first and second parts of the duodenum. The colon is loaded with barium from the barium meal given twenty-four hours previously.

admission he developed sudden very severe abdominal pain associated with vomiting.

ON EXAMINATION.—He was a shocked old man showing the typical signs of a perforated peptic ulcer. He suffered from asthma and was a poor operative risk.

OPERATION.—Ten and a half hours after perforation, two hours after admission, under a general anæsthetic, and after intravenous administration of one pint (600 c.c.) of saline, laparotomy was performed by Mr. Fleming through an upper midline incision. This revealed a perforation of 0·5 cm. (0·2 in.) in diameter on the anterior surface of the first part of the duodenum, and a large amount of brownish fluid in the peritoneal cavity. The perforation was closed with three catgut sutures, the free ends of the outer two being used to anchor omentum over the area. Some slight misgivings were felt by the surgeon at the time owing to the friability of the tissues; but the closure appeared perfectly sound.

PROGRESS.—Penicillin in doses of 100,000 units was given three-hourly. Intravenous fluid therapy was continued, and nothing was given by mouth for the first twenty-four hours. Gradually increasing amounts of water were subsequently given by mouth. On the third post-operative day, however, when 4 oz. of fluid (114 ml.) were being given hourly he suddenly vomited 8 oz. (228 ml.). The stomach was aspirated, but very little was obtained, and shortly after this the patient complained of a sudden epigastric pain. He was obviously shocked, and brown fluid similar to that found in the peritoneum at operation was seen to be oozing from his wound. It was clear that a duodenal fistula had formed as the result of reperforation.

For the next five days he was treated with intravenous glucose and saline together with continuous gastric aspiration. Between two and four pints (1200–2400 ml.) of fluid drained each day from the fistula; leakages into the dressings made a more accurate estimation impossible.

On the third day of this treatment attacks of tetany, with typical carpopedal spasm, set in. This responded only sluggishly to intravenous calcium gluconate (20 ml. of a 10 per cent solution two-hourly) which, together with intravenous Ringer's solution, scarcely controlled the spasms. In retrospect it seems possible that magnesium deficiency was contributing to the pathological state. Blood-chlorides during this time ranged from 498 to 590 mg. per cent and blood-urea from 128 to 232 mg. per cent.

On July 3, five days after formation of the fistula, it was decided to attempt to block the fistula with the Miller-Abbott tube, as previously described. The patient's general condition was by now very poor; he

FIG. 107.—*Case* 2. The stomach, the duodenal cap (D) and the fistula (F) are outlined by barium.

was incontinent, wasted, and anæmic. After a transfusion of one pint of blood he was moved to the Radiographic Department, but promptly went into tetany. However, an intravenous dose of calcium gluconate (30 ml. of 10 per cent solution) brought the attack to an end in about thirty minutes.

Radiography after a barium meal demonstrated a large fistula starting from the first part of the duodenum and communicating with the right anterior subphrenic space, which was outlined with barium (*Figs.* 107, 108). The modified Miller-Abbott tube was passed as previously described, but could not be induced to turn towards the pylorus until 5 ml. of mercury had been introduced into the balloon, with the patient placed in the right lateral position. When this had been done radiography showed that the balloon containing mercury was blocking the barium-outlined fistula (*Fig.* 108). The tube was therefore fixed in position and the patient returned to the ward. Citrated milk was fed down the tube, and it was soon obvious that discharge from the fistula was much reduced. Only 8 oz. (228 ml.) escaped during the next ten hours, but then the rate of escape increased and radiography showed that the balloon had descended into the second part of the duodenum; this accident was due to not having taken up enough 'slack' in the tube after the balloon had been manipulated into position. Nevertheless, feeding was continued down the tube and in addition the patient was transfused with one pint each of plasma and blood.

During the next morning the balloon was replaced into position in the fistula under fluoroscopic guidance, but unfortunately, shortly after this, the patient pulled the tube up. He was not fit for further manipulations so the tube was not replaced. Fistula drainage increased to five pints (3 l.) in twenty-four hours and he died forty-eight hours later.

SUMMARY OF POST-MORTEM FINDINGS (P.M. No. 327/49).—

General.—The body was that of a thin old man. Bronchopneumonia was present with milky fluid in the

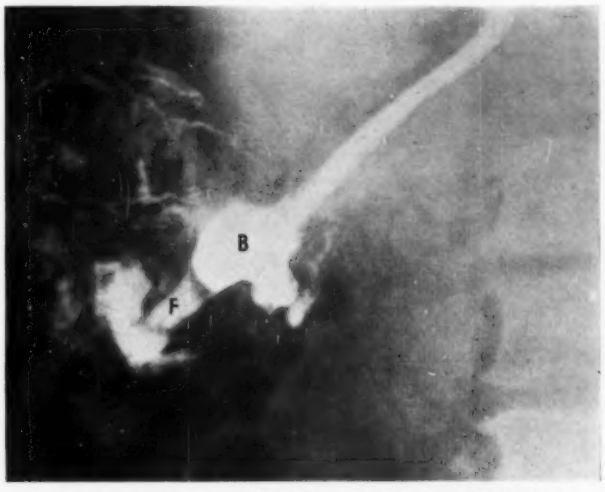

FIG. 108.—*Case* 2. The balloon of the Miller-Abbott tube (B) contains mercury and is occluding the internal opening of the fistula (F), which is outlined with barium. Compare the shape of the balloon with that of the duodenal cap shown in *Fig.* 107. (The second part of the duodenum is not outlined.)

trachea. The liver showed mild fatty degeneration with centrilobular necrosis. The only other general finding of note was a small hæmorrhage into the left suprarenal gland.

Local Condition.—The fistula opened at the unhealed operation wound via a large subjacent abscess and communicated with the right anterior subphrenic space, which contained barium.

The origin of the fistula was a defect measuring 2·5 × 3·5 cm. in the anterior wall of the proximal duodenum

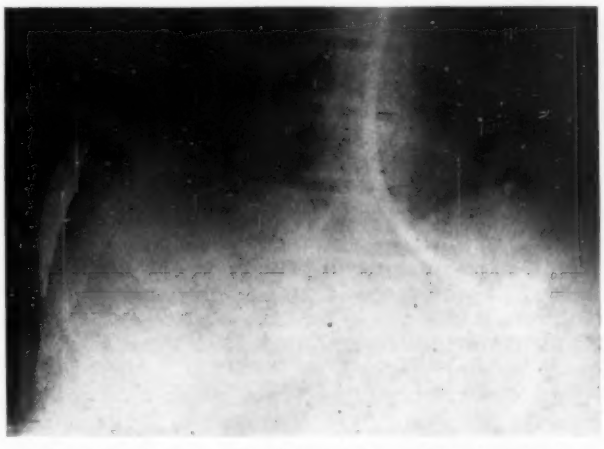

FIG. 109.—*Case* 2. The right anterior subphrenic space is outlined by barium which has leaked from the fistula.

and the pylorus. At its distal margin there remained several catgut sutures from the repair of the original perforation.

Fig. 110, which is a photograph taken at post-mortem examination, shows the duodenal defect and the modified Miller-Abbott tube placed in position, corresponding with that in the ante-mortem radiograph (*Fig.* 109).

DISCUSSION

The procedure adopted in these two cases embodies almost all of the previously accepted methods which have been used in the treatment of these difficult surgical problems, but in addition an entirely internal obturator is used. The effectiveness of the obturator is well demonstrated by the two cases so treated, since the drainage from the fistula increased markedly when the balloon was misplaced either proximally or distally to the fistulous opening in the duodenum.

FIG. 110.—*Case* 2. Photograph taken post mortem of the duodenal perforation (P) with the balloon placed in position and occluding it. A section of the gastric lesser curvature has been removed to show the tube. The second part of the duodenum (D) runs almost directly downwards from the fistula.

The weakness of the method appears to be the insecure fixation of the balloon at the site of the fistula. To overcome this it is proposed in future to use an additional balloon on the tube which will, by virtue of its size, rest above the pylorus and act as an anchor.

In *Case* 1, where the balloon remained in position for four and a half days, the result of the treatment was most satisfactory; indeed a few months later the patient returned to hospital for a two-stage thoracolumbar sympathectomy for his essential hypertension.

The result of the treatment in *Case* 2 was less impressive. Perforation of peptic ulcers in the aged, however, carries in itself a high fatality and post-operative reperforation must amount nearly to a death sentence. It is felt that the treatment with the modified Miller-Abbott tube should have been started sooner after the appearance of the fistula, before the general condition had deteriorated and co-operation had been lost.

Death may have been accelerated by the extravasation of barium into the subphrenic space (*Fig.* 109), but barium-meal examination is essential, and it seems that this risk must be taken.

Even though the patient did not survive, temporary technical success was achieved, which indicates the practicability of the method here described, and the desirability of further trial. It should be noted that if this method is used for fistulæ below the level of the ampulla of Vater, a further suction channel will be necessary to keep the proximal duodenum empty of secretions.

SUMMARY

The aetiology, treatment, and prognosis of duodenal fistulæ are briefly reviewed.

Some so-called duodenal fistulæ are probably biliary fistulæ associated with an incompetent ampulla of Vater.

A new method of treatment of lateral duodenal fistulæ in the proximal duodenum is described. The balloon of a Miller-Abbott tube is used as an internal obturator, while nourishment is provided through what is normally the suction channel of the tube.

Two cases in which this method was used are described in detail. In one case it was successful, in the other only a temporary technical success was achieved.

I am much indebted to Mr. A. Elliot Smith, Mr. E. G. Moloney, Mr. D. A. Abernethy, and Mr. J. P. Fleming for permission to publish details of their cases.

I am most grateful to Dr. B. N. Klukvin for radiological assistance and to Mr. A. Elliot Smith and Mr. J. N. Ward McQuaid for advice and criticism; and to Mr. E. L. P. Tugwell and Mr. R. Hill for the photographs.

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PERFORATION OF ADENOCARCINOMA OF ILEUM

By PHILIP SOMERVILLE, London

Adenocarcinoma occurring in the jejunum or ileum is rare when compared with carcinoma of other parts of the intestinal tract. It is usually single in a polypoid or annular form. The actual incidence varies according to the particular series quoted—Rankin and Mayo (1930) 0·62 per cent; Christofferson and Jacobs (1939) 1·6 per cent; Ewing (1940) 3·08 per cent; Raiford (1932) 4·6 per cent; and others—but it would seem that the lower values are the more likely. The literature has been reviewed both in this country and the U.S.A. Fraser in 1945 reported 6 cases (seen in ten years) from the Western Infirmary, Glasgow. In the United States Cameron (1938) reviewed 109 cases, and more recently Pridgen, Mayo, and Dockerty (1950) reviewed 63 cases seen at the Mayo Clinic between 1907 and 1947. The latter state that there are over 500 cases reported in the literature, mostly in small series. The commonest method of presentation is recurring attacks of chronic obstruction. Occasionally there is a more dramatic onset, with acute obstruction, intussusception, or perforation.

The following case record illustrates one of the rarest methods of presentation, sudden and spontaneous perforation being recorded on few previous occasions.

Fig. 111.—Interior view of bowel, showing tumour. (×½.)

Fig. 112.—External view of specimen, showing perforation through adenocarcinoma.

CASE REPORT

A. T., a man aged 69 years, was admitted to King's College Hospital on Jan. 8, 1950, with a history of sudden onset of pain in the centre of his abdomen five hours previously. At first it was colicky, with frequent spasms, followed before long by continuous pain. He vomited once an hour after the onset, but from then on had no nausea.

He gave a history of diarrhœa on and off for three years, which had been investigated on two previous occasions, three years and one year ago respectively. In 1946, at the onset of the diarrhœa, he had been fully examined and investigated with a barium meal and follow-through which showed no abnormality. His Hb was 86 per cent. The diarrhœa recurred at intervals and he developed lassitude. It was noticed that he had a brown pigmentation of his skin but not of his mucous membranes, and this pigmentation he had had all his life. He was admitted to hospital in February, 1949, for investigation.

At this time he was passing 4 or 5 stools daily, which were pale and bulky. He had lost 2 st. in weight in the past eight years. There was no blood or pus in his stools, but an abnormal fat content.

Total fat 48·2 g./100 g.
Split fat 35·0 g./100 g.
Unsplit fat 13·2 g./100 g.

Sigmoidoscopy normal. A Miller-Abbott tube was passed and on screening was seen to be in the duodenum. Aspiration of fluid showed it to be neutral to litmus and there was no evidence of pancreatic enzymic activity. His serum-calcium was 4·6 mg. per cent, and he exhibited a positive Trousseau's sign. He was regarded as a case of steatorrhœa due to pancreatic deficiency and was treated with a low-fat, high-protein, and moderate carbohydrate diet with the addition of Fersolate, Pancreatin, calciferol, and calcium gluconate.

There was no previous history of peptic ulcer. On examination he did not give the impression of being seriously ill but was obviously in pain. His temperature was 97, pulse 72, and respiration 30. Tongue clean; abdomen moved only a little on respiration. There was generalized tenderness and guarding but no distension. There was no clinical evidence of free fluid and no peristalsis could be heard. There was some tenderness per rectum. After a few hours his temperature rose to 99·5 and pulse to 96. It was obvious that he had a developing peritonitis and the onset and some of the clinical features suggested a small perforation of a peptic ulcer. A radiograph of the abdomen was taken in the erect position. It showed no evidence of subphrenic gas, but a few coils of small intestine were dilated and showed the presence of gas and fluid levels.

At Operation.—General anæsthesia (pentothal 0·5 mg., tubarine 30 mg., N_2O, O_2 and ether).

A long right paramedian incision was made and on opening the abdomen a quantity of turbid free fluid escaped. The small intestine appeared slightly distended and diffusely inflamed, with no evidence of peristalsis. The stomach and duodenum were normal. The appendix was retrocæcal but normal in appearance. The large intestine was normal throughout. The liver and gall-bladder were normal. On examining the small intestine a partial stricture was found about half way between the

duodenojejunal junction and the cæcum. Both intestines above and below were a little distended, but that above more so. On one side of the intestine at the site of the stricture was a small perforation through which a quantity of fluid and gas could be seen escaping. As far as could be seen there were no enlarged glands in the mesentery. A resection of 6 in. of intestine with a wedge of mesentery was performed, with a side-to-side anastomosis because of the inequality of the bowel ends. The abdomen was closed in layers and a drainage-tube inserted through a midline stab incision into the pelvis.

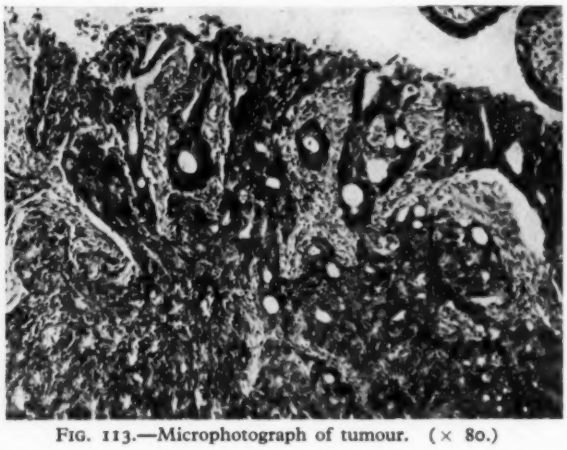

FIG. 113.—Microphotograph of tumour. (× 80.)

POST-OPERATIVE COURSE.—An intravenous transfusion of glucose–saline was started during the operation and continued for 36 hours. Gastric suction was applied for the first 24 hours and the patient was treated with intramuscular penicillin 200,000 units 4-hourly, and sulphadiazine 1 g. 4-hourly. He made a satisfactory and uneventful convalescence, being discharged after three weeks. Fifteen months later he showed no evidence of recurrence and was well, with less diarrhœa and having put on several pounds in weight.

PATHOLOGICAL REPORT.—The specimen consists of a portion of ileum measuring 14 cm. in length (*Figs.* 111, 112). It has been laid open to show a stricture ½ cm. long. The circumference of the bowel through the stricture is 5½ cm. as compared with 8 cm. elsewhere. At the site of the stricture the mucosa is thickened and yellowish, and there is a small perforation 2 × 5 cm. The peritoneal surface appears acutely inflamed. Four lymph-nodes were found in the attached mesentery.

Section through the stricture shows a moderately well-differentiated adenocarcinoma which is infiltrating the muscle coat (*Figs.* 113, 114). The appearances are not those of a carcinoid tumour and special staining methods show argentaffin granules to be absent. The peritoneal surface is covered by a fibrinopurulent exudate.

Section of the four lymph-nodes shows no evidence of metastasis.

DISCUSSION

A search of the literature shows that perforation of a small intestinal carcinoma is a rare occurrence. The literature was reviewed by Brocq (1942), who added 1 case to 8 others he had found previously described. Of these 9 cases only 3 survived. Brocq's case, operated on by Kuss, was a man of 61 years who complained of colicky abdominal pain, maximal in the left iliac fossa, which had been present for nine hours before admission. Laparotomy revealed a mass consisting of adherent coils of ileum with an irregular perforation on the afferent loop. A resection was performed with an end-to-end anastomosis. The patient made a satisfactory recovery and the pathologist reported on it as an adenocarcinoma.

A second successful case was operated on by Dencks (1927). A man of 42 years presented with sudden acute abdominal pain two hours after his lunch. At operation a small annular tumour was found, with a perforation on the mesenteric border. Wide resection with end-to-end anastomosis was done.

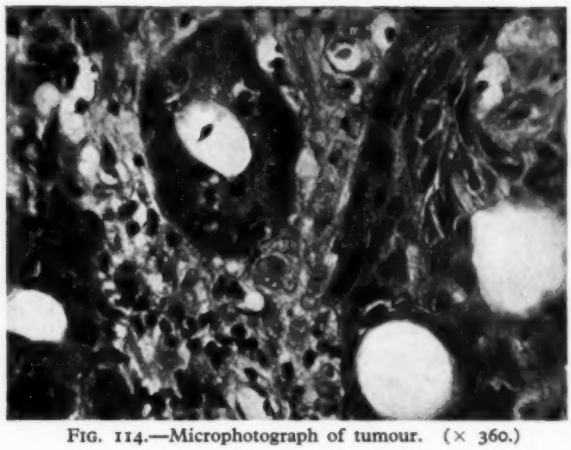

FIG. 114.—Microphotograph of tumour. (× 360.)

The third success was reported by Salmon (1939) in a man of 58 years who had a sudden onset of acute abdominal pain accompanied by vomiting with generalized abdominal tenderness and rigidity. In spite of the absence on radiography of subphrenic gas, a diagnosis of perforated peptic ulcer was made. Laparotomy revealed free fluid and a 2-mm. perforation, 60 cm. from the duodenojejunal junction. The tumour was resected with end-to-end anastomosis.

Spontaneous perforation with general peritonitis is recorded by Fraser in a man of 51 years in the upper jejunum; by Christofferson and Jacobs in a man of 48 years, 18 in. from the ligament of Treitz; by MacEwan (1922) in a man of 20 years at the base of a pedunculated carcinoma of the ileum; by Stein (1937) in the terminal ileum; and by Kahn and Bay (1942), in a woman of 62 years, 18 in. from the ligament of Treitz. In all these cases death occurred from peritonitis, and only in the first two was resection performed owing to the patient's condition. The former died after six days and the latter on the fifth.

Johnson (1922) mentions 2 cases found in University College Hospital Museum, and Venot and Parcellier (1913) mention 2 further cases.

Slower perforation has also been described on numerous occasions with the formation of localized abscesses or fistula formation with neighbouring bowel. Pridgen and others state that in one-third of all their cases the growth has perforated the serosa, but there is no mention of spontaneous perforation with general peritonitis.

Similar perforations of sarcoma of the small intestine, although rare, also occur. Lewis (1939) reported 6 cases out of 400 reviewed; Fraser (1945) mentions 3 out of 9 cases.

The case recorded above would no doubt have presented in the more usual way with obstruction if perforation had not intervened. The patient had been under medical observation for two years but no suspicion of carcinoma of the small intestine was

raised. A barium meal failed to show any abnormality two years previously. Rankin and Mayo (1930) found the average duration of symptoms was 14 to 15 months, but symptoms up to four years have been described. It is probable that the carcinoma in the author's case, if present, was insignificant in size at that time. His steatorrhœa was probably quite unconnected with the growth and was in no way due to blockage of lymphatics. Anæmia was stressed by Mayo as of special pre-operative significance. Two years previously his Hb was 86 per cent and in spite of iron and liver therapy it continued to fall until at six months before operation it was 74 per cent. It is unfortunate that his fæces were not examined for occult blood.

From the recorded cases it can be seen that perforation of carcinoma of the small intestine may present in dramatic form when large, closely simulating a perforated peptic ulcer, or less dramatically when small, with sudden onset of general peritonitis. The perforation in this case was not large enough to produce the classical picture of perforated peptic ulcer, but was sufficiently close to warrant its consideration and to make an X-ray examination of the abdomen for subphrenic gas. In the absence of a suggestive previous history, a recent barium meal, or a palpable mass in the abdomen, a correct pre-operative diagnosis is virtually an impossibility.

The treatment needs no special comment since where possible it is resection followed by anastomosis.

The overall operative mortality is given by Cameron (1938) as 30 per cent, but Pridgen and others (1950) state that in the Mayo Clinic series it has fallen from 55 per cent in the first decade to 3·2 per cent in more recent years. Perforation with general peritonitis seems to have been followed by a high mortality as judged from the literature, but no doubt with the aid of modern methods of pre- and post-operative treatment it ought to be greatly reduced.

SUMMARY

1. A case is recorded of adenocarcinoma of the upper ileum presenting with spontaneous perforation.
2. The literature of perforation of carcinoma of the small intestine has been reviewed.
3. The clinical picture is similar to that of perforated peptic ulcer and the treatment is resection.
4. The mortality has been high in the reported cases.

I wish to express my thanks to Sir Cecil Wakeley for permission to publish this case and also to Dr. Hall, of the Pathological Department, for the histology. My thanks are also due to Mr. Smith, of the Photographic Department at King's College Hospital.

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CHONDROSARCOMA OF THE ILIUM COMPLICATING HEREDITARY MULTIPLE EXOSTOSES

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THE ilium is one of the common sites of occurrence of chondrosarcoma, but the association of the latter with multiple hereditary exostoses is of comparative rarity and worthy of record.

CASE REPORT

HISTORY.—The patient, F. H. W., was a thick-set, obese man, aged 54 years, normally very active: a pharmacist, optician, and radiographer.

At the time of admission in 1949 he had been bedridden for more than a month from weakness of the left leg and intolerable sciatic pain.

The first sign of bone disturbance appeared at the age of 6, when a swelling developed on the proximal end of the right humerus. Numerous other swellings became apparent during his youth, particularly in the neighbourhood of the knee-joints. All these exostoses ceased to grow at about the age of 22 years. Apart from exostoses he developed no skeletal deformities. There was a marked familial history. The paternal grandfather, father, and elder brother are known to have had multiple exostoses, but none of them had been in any way incapacitated by this condition.

The patient noticed no further change in the state of his exostoses until the age of 45 years, when he first noticed a large swelling of the left hip. A diagnosis of simple chondroma was made, but no active treatment was advised. Three years later, however, the condition was evidently progressing and it was decided to carry out a local excision of the chondroma, and a tumour weighing 8½ lb. was removed. Two years later a recurrence the size of a grapefruit developed, which was also removed, and thereafter he had four local tumour excisions, each followed rapidly by local recurrence.

In March, 1949, nine years after the original appearance of the tumour, swellings were noticed not only in the gluteal region but also below the inguinal ligament. A little later severe sciatic pain developed and the patient had to take to his bed. It was then decided that a

hindquarter amputation was his only hope of relief and he was referred to Sir Gordon Gordon-Taylor.

A left hindquarter amputation was performed on Aug. 13, and was attended with unusual difficulty, medial extension of the growth into the pelvis making it very difficult to secure the common iliac vessels. Moreover, in that sacro-iliac disarticulation would not have resulted in complete removal of the growth, it was found necessary to divide the sacral ala 2 cm. medial to the sacro-iliac joint. Unfortunately in the course of this removal the spinal theca was opened and although this was sutured, a cerebrospinal fistula developed. This fistula closed spontaneously after three weeks, and the patient subsequently made satisfactory progress.

DESCRIPTION OF AMPUTATION SPECIMEN AFTER DISSECTION.—The specimen exhibited two outstanding pathological conditions: (1) Multiple hereditary exostoses; (2) Chondrosarcoma of the ilium (*Figs.* 115, 116).

The former presented as a number of cartilage-covered exostoses and calcified cartilaginous outgrowths on the upper ends of the tibia and fibula, on the lower end of the femur, and on the crest of the ilium. The exostoses on the tibia, fibula, and ilium were small, but one group on the femur formed a large irregular mass grooved by the sciatic nerve.

The chondrosarcoma appeared to have arisen from the dorsum ilii, which it completely covered. Thence it had burrowed through the great sciatic notch into the

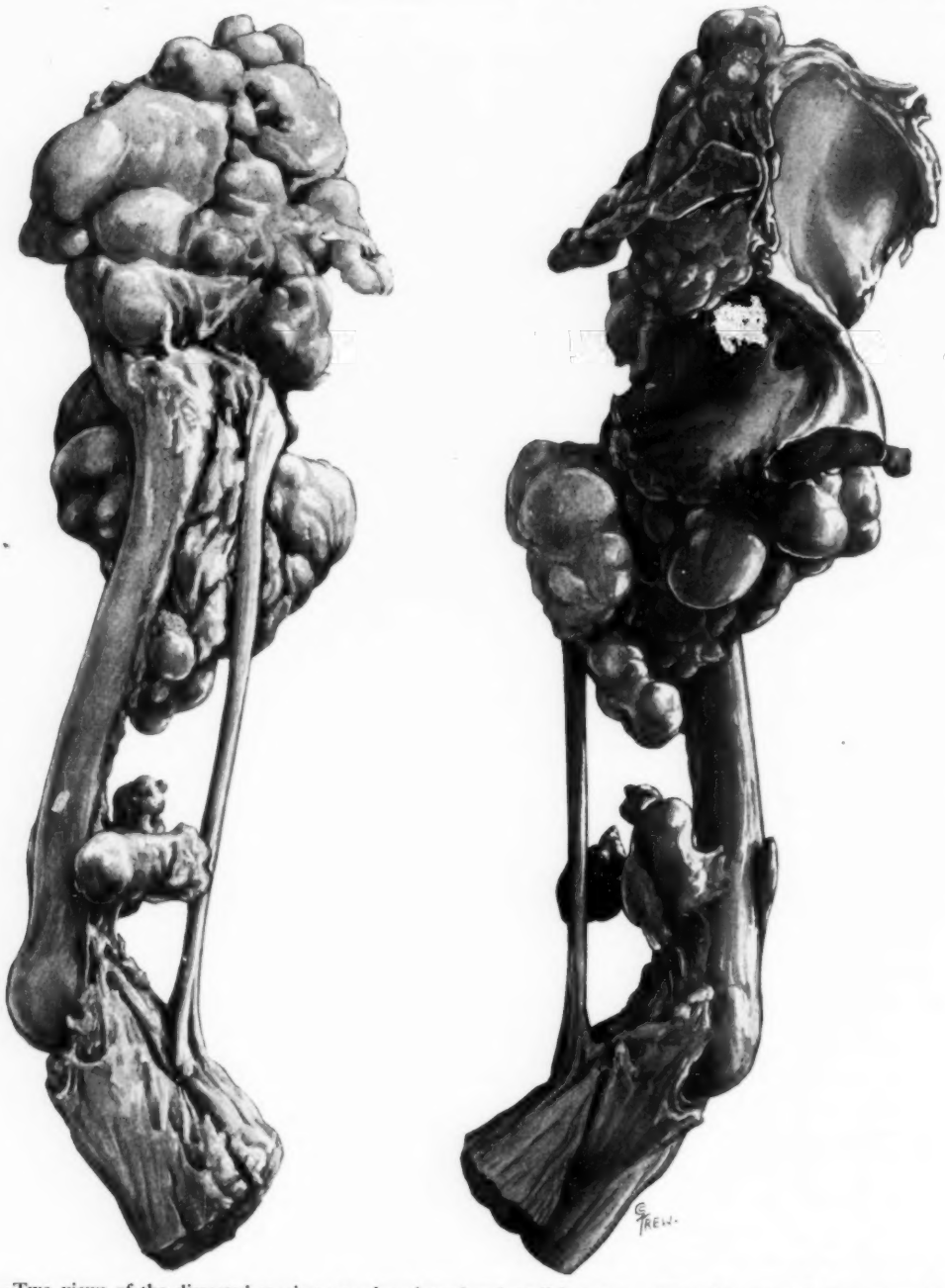

FIG. 115.—Two views of the dissected specimen to show lateral and medial aspects. There is a mass of exostoses at the lower end of the femur and two small exostoses on the crest of the ilium. The chondrosarcoma covers the dorsum ilii and has spread over the neck of the femur to invest the sciatic nerve and into the pelvis to cover the front of the sacrum and sacro-iliac joint.

pelvis, and had spread downwards over the back of the neck of the femur. From there it had passed forward on the external aspect of the ischiopubic ramus below the neck of the femur, almost to the symphysis pubis, and had also penetrated far down the posterior muscular compartment of the thigh.

The tumour consisted of rounded, confluent masses of pale, soft, cartilaginous and mucoid material, in the main relatively encapsulated. However, in the region posterior to the neck of the femur the soft tissues and the sciatic nerve were inseparably infiltrated by growth, whilst a similar diffuse infiltration was found in the pelvis involving the sacral plexus, and surrounding the internal iliac artery.

HISTOLOGY.—Dr. A. H. T. Robb-Smith reported on a biopsy taken in June, 1945: "There are masses of cartilage lying in granulation tissue. The nuclei are irregularly arranged and variable in size, indicating this tumour to be a chondrosarcoma".

Professor R. W. Scarff reported on the tumour removed at hindquarter amputation, 1949: "Chondrosarcoma. Section shows a tumour composed of cartilage cells which show atypical and irregular proliferation".

DISCUSSION

It would appear that this is a typical case of hereditary multiple exostoses, a condition often referred to as diaphysial aclasis; the use of the former term, however, avoids the implications of a doubtful aetiology. Jaffe (1943) has estimated that the incidence of sarcoma complicating multiple exostoses is over 10 per cent. In the majority of instances the tumour is a chondrosarcoma. Fairbank (1949) states that this malignant degeneration occurs particularly on the femur, scapula, or pelvis, and arises from the cartilaginous cap of an exostosis. The case reported would appear to conform to the usual pattern, as a chondrosarcoma arose from an ilium on which exostoses were simultaneously demonstrable.

This case also illustrates that the increase in size of an exostosis after puberty calls for investigation, and that the chondrosarcoma which such investigation will usually reveal calls for radical surgery. The development of a simple exostosis after puberty has been recorded (Ashhurst, 1916), but the appearance of a fresh tumour, especially when accompanied by pain, strongly suggests that sarcomatous degeneration has occurred. Biopsy of a suspected tumour may be inconclusive, as the histological differentiation between a benign and a malignant chondroma is extremely difficult. Simple enucleation of such a tumour, however, is usually followed by recurrence. Accordingly, when a histological diagnosis of chondrosarcoma has been made, or when recurrence has followed local excision of a supposedly benign chondroma, block resection is needed (Gardner, 1937). This will usually mean amputation, and where a chondrosarcoma arises from the pelvic bones this will mean hindquarter amputation.

With the advent of adequate blood replacement and improved chemotherapeutic agents, the overall mortality of the hindquarter operation has fallen to well below 15 per cent. The chondrosarcomata form the most favourable indication for this heroic procedure, some cases being free from recurrence more than ten years after operation (Gordon-Taylor and Patey, 1946). These considerations should encourage the wider adoption of the hindquarter amputation in the treatment of such tumours.

SUMMARY

A case of chondrosarcoma of the ilium complicating hereditary multiple exostoses and treated successfully by hindquarter amputation is described. The sinister import of the recrudescence of growth in an exostosis occurring after puberty is stressed, and the inadequacy of local enucleation in the treatment of chondrosarcoma is emphasized.

FIG. 116.—Radiograph of the dissected specimen. The exostoses are characteristically composed of cancellous bone containing areas of hypercalcified cartilage. The chondrosarcoma is in the main poorly calcified and although there is some irregular absorption of the ilium the main outline and structure of the latter are preserved.

We are extremely grateful to Sir Gordon Gordon-Taylor for permission to publish this case and for his interest and encouragement. We also wish to thank Mr. P. Wiles for much helpful criticism.

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ACUTE DIVERTICULITIS OF THE CÆCUM AND ASCENDING COLON

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ACUTE diverticulitis of the sigmoid colon has earned for itself the nick-name of " left-sided appendicitis ", but the reverse phenomenon, right-sided abdominal inflammation originating in a diverticulum of the cæcum or ascending colon, is less widely recognized. The importance of such a condition lies in the fact that it may simulate either acute appendicitis on the one hand or carcinoma of the cæcum on the other.

Multiple diverticula may, of course, extend so far proximally as to involve the ascending colon or cæcum (Spriggs and Marxer, 1927), but according to Boyden (1950) and Mayo and Blunt (1950) inflammatory sequelæ in these situations are rare. For the most part, the recorded cases of right-sided diverticulitis have been related to a solitary diverticulum. This differs from the more common multiple diverticulosis in that it occurs equally in both sexes, and just as commonly below the age of 40 as above it (Anderson, 1947), and is entitled to be regarded as a separate entity.

The earliest case recognized and reported as solitary cæcal diverticulosis is that of Potier in 1912. Bennett-Jones (1937) recorded 3 cases, and collected 17 from the literature. Since then the condition has been described with increasing frequency, and in 1947 Anderson was able to collect and review 91 cases, adding 8 from the records of the Mayo Clinic; of these 8, however, 3 occurred in the presence of multiple diverticula, and should not properly be included here. Recent reports in the British literature include those of Gordon-Taylor (1939), Grace (1939), Hendtlass (1944), Dorling (1945), Fairbank and Rob (1947), Kirkman (1950), and Shaw and Siegler (1950), including in all 9 cases.

This considerable accretion to the literature does not mean an increasing incidence, nor yet does it indicate that the condition is a common one, awaiting only wider recognition. It is, however, conceivable that some cases of diverticulitis have been in the past ascribed to subacute or resolving appendicitis, some abscesses drained in the belief that they were of appendicular origin, some normal appendices incriminated and excised subsequent to inflammation in an unrecognized diverticulum, and even some phlegmonous masses of the cæcum diagnosed as carcinoma and excised or short-circuited without pathological proof of their benign nature. While such possibilities of error exist, it is clear that the true incidence of cæcal diverticulitis cannot be estimated.

AETIOLOGY

Some authors (e.g., Schnug, 1943) have distinguished a true congenital diverticulum, and a false or acquired type, the former being characterized by possession of complete muscular coats similar to those of the bowel wall, the latter consisting of a mucosal pouch covered by peritoneum and fibrofatty tissue. The validity of this distinction seems open to doubt, but it is of little importance in this site except in relation to aetiology.

Few of the factors which are usually cited to account for the development of an acquired diverticulum would appear to apply to the cæcum. It is no doubt subject to periodic increases of tension, even in the absence of the cæco-colic sphincter mechanism which exists in rats but which has never been demonstrated in man (Spencer, 1921). Spasm of the ascending colon might be considered capable of raising intracæcal tension, although the degree of competency of the ileocæcal valve implied is perhaps debatable. Again, there are few lesions which might be expected to result in weakening of the cæcal wall, but healed solitary ulcer has been mentioned by Fairbank and Rob (1947) and others. Greensfelder and Hiller (1929) have emphasized the role of appendicectomy, and state that intramural stump abscess, necrosis of muscle by inclusion and strangulation in a purse-string suture, and the traction effect of local adhesions may each lead to diverticulum formation at the site of the appendix stump. These authors, however, could find only 4 diverticula produced by such mechanisms in a review of over 5000 laparotomies and 400 autopsies.

True congenital diverticulum is well exemplified by Odqvist and Petrèn's case (1931), of a three-year-old child, who at autopsy was found to have a Meckel's diverticulum and a large well-developed diverticulum of the cæcum. The coexistence of the two seems to rule out the hypothesis that cæcal diverticulum represents a misplaced vitello-intestinal remnant. These authors suggested an origin from totipotent cells in the cæcal wall, but for this hypothesis there would appear to be little evidence. Greensfelder and Hiller (1929) refer to an appendix cæci which, they state, appears in the embryo, but normally disappears before development of the definitive appendix; to its persistence they ascribe the occurrence of cæcal diverticulum. I can find no embryological authority for this description, and mention it only because it appears to have gained some credence in American papers.

Discussing the development of enterogenous cysts, Evans (1929) has suggested that these share with diverticula and also reduplication of the bowel an essentially similar aetiology, deriving from irregularities in the process of vacuolation of the intestinal entoderm. This would appear to be the most acceptable explanation of solitary cæcal diverticulum. Yet another possibility, however, is suggested by the third case reported here, in which the diverticulum is situated at the base of the appendix, and is perhaps accounted for by persistence of the apex of the conical infantile cæcum.

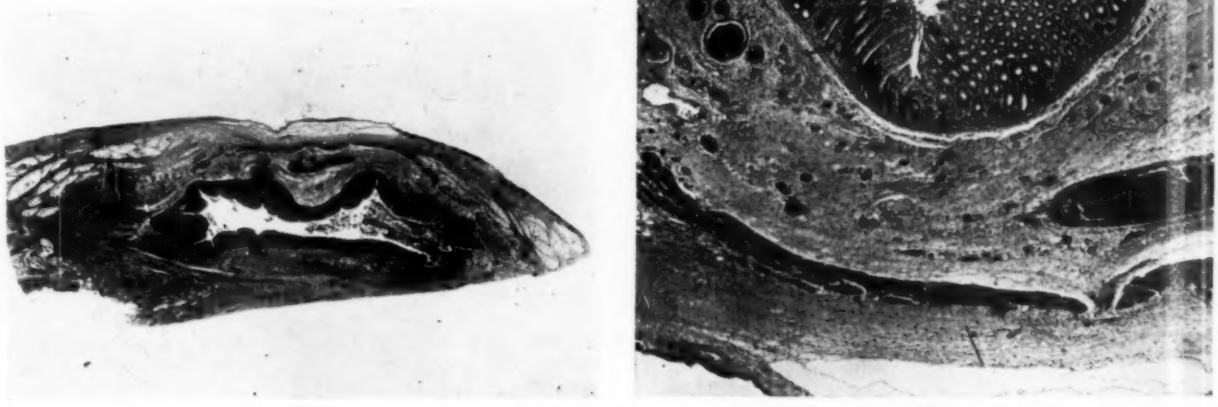
PATHOLOGY

It is not possible to determine from the literature the relative frequency of congenital and acquired

diverticula. Baker and Carlile (1943) noted that of the 39 cases they reviewed, 11 had been described as congenital and 10 as acquired.

The commonest site, according to Illingworth and Dick (1949), is the medial aspect of the cæcum, but in most of the recorded cases the anterolateral or posterior aspects have been affected. The diverticulum frequently lies just above the level of the ileocæcal junction, and belongs strictly to the ascending colon (Baker and Carlile, 1943). Solitary diverticula, in contrast to the multiple form, are not as a rule associated with appendices epiploicæ.

The size of the diverticulum varies, but it commonly measures 1 to 3 cm. both in length and diameter. It is possible that the truly congenital forms tend to be the larger, as in Odqvist and Petrèn's case where the diverticulum formed a finger-like process 8·5 by 3 cm. Baker and Carlile described a diverticulum containing a fæcolith "as large as a lemon".



A B

FIG. 117.—*Case* 1. Showing section through diverticulum with mucous and muscular layers. (A, × 2·5; B, × 16·5.)

The solitary diverticulum rarely comes to the notice of the surgeon or pathologist unless it is inflamed. It may then be distended into globular form, or perforated, collapsed, and imbedded in a phlegmonous mass which lies outside, but is closely adherent to, the cæcal wall. Fæcoliths are common; gangrene occurs and may infrequently involve the cæcal wall, but perforation into the free peritoneal cavity is fortunately exceptional. Inflammation may be followed by spontaneous resolution, or by abscess formation, and surgical drainage has not infrequently resulted in fæcal discharge lasting many months. In two cases there has been histological evidence of local tuberculous infection (Baker and Carlile, 1943)

An indurated cæcal mass, fixed perhaps to the posterior abdominal wall, and accompanied by enlargement of the regional lymph-nodes, may at operation suggest to the exploring finger and even to the experienced eye the diagnosis of malignancy. This is particularly likely when the diverticulum lies behind the cæcum, and Moon and Schenk (1945) suggest that palpation of its orifice through the overlying bowel wall is diagnostic. Unfortunately such an orifice, indurated by inflammation, may closely simulate ulceration, and so confirm the erroneous impression already formed.

CLINICAL FEATURES

The symptoms of diverticulitis mimic almost exactly those of appendicitis, but are described by Henry (1949) as being more prolonged and less severe. In the cases reviewed by Schnug (1943), the only distinguishing features were of more statistical than diagnostic import, vomiting being relatively less common and a clinically palpable mass more common than in appendicitis. A previous history of pain in the right iliac fossa was obtained in 25 per cent of the cases.

It is not surprising, therefore, that the preoperative diagnosis has been appendicitis in 84 per cent of cases (Anderson, 1947), less frequent alternatives being salpingitis, degenerating fibroids, or carcinoma. On 4 occasions the condition has been correctly diagnosed before operation; so venturesome a diagnostic longshot is reasonable when symptoms typical of appendicitis occur in a patient who has already undergone appendicectomy. It may be profitable also to consider, and to look for, a cæcal diverticulum in the course of interval appendicectomy following resolution of an abscess in the right iliac fossa.

The majority of cases, however, will come to light only when an operation for apparent appendicitis reveals a normal appendix and a cæcal mass. Diverticulitis should then be remembered as an alternative to carcinoma, regional enteritis, ileocæcal tuberculosis, and actinomycosis.

TREATMENT

A small non-inflamed diverticulum may safely be invaginated, when a few sutures across its base will prevent its reappearance. Inflamed diverticula should be excised, but if this entails dissection through an inflammatory mass simple drainage should be substituted. Exteriorization of the cæcum (Frehling, 1945) or resection of the Lahey-Mikulicz type should rarely be necessary, but local resection of the cæcal wall may be performed.

Hemicolectomy for cæcal diverticulitis is an unnecessarily severe procedure, and has carried a mortality of 11 per cent as opposed to the overall

mortality of 6 per cent. It is clear that this operation should be avoided unless the operator's suspicions of carcinoma strongly outweigh the possibility of diverticulitis.

Given modern chemotherapeutic agents in combination with excision or simple drainage, few cases should now terminate fatally.

CASE REPORTS

Case 1.—E. P., a married female aged 30, was admitted to Hammersmith Hospital on Sept. 14, 1950, complaining of abdominal pain of twelve hours' duration. She had experienced vague pains in the right iliac fossa for two years, and had suffered one other acute attack three months previously. The pain started in the central abdomen, and after three hours shifted to the right iliac fossa. There was anorexia, but no nausea, vomiting, or upset of bowel function. The temperature was 100° F. and the pulse 100. Palpation of the abdomen revealed no mass, but there was slight muscular rigidity and marked tenderness in the right iliac fossa. The leucocyte count was 14,700 per c.mm.

FIG. 118.—*Case* 2. Drawing showing a small solitary diverticulum.

The diagnosis of acute appendicitis was made and operation was undertaken through an oblique muscle-splitting incision. The appendix was found to be normal, and there were no enlarged mesenteric glands. Lying behind the cæcum at the level of the ileocæcal junction there was felt a hard circular mass. Carcinoma being suspected, the incision was enlarged and right hemicolectomy was carried out. The patient's post-operative course was uneventful, and she was discharged sixteen days later.

PATHOLOGICAL REPORT (Dr. Harrison and Dr. Weinbren).—" On the posterior wall of the cæcum was a flat circular area of thickening 60 mm. in diameter and 7 mm. thick. On cutting this, it was found to be a thickening of fibro-fatty tissue outside the bowel wall, and in the middle of it was an irregular, ramifying abscess track about 20 mm. long and up to 5 mm. wide. No communication could be found between this and the lumen of the gut or appendix. Sections show subacute septic cellulitis in the fatty tissue, without any significant change in the inner part of the colon. Further section (*Fig.* 117) across the abscess track at a different level shows it to be lined by colonic mucosa. In view of this there is little doubt that the lesion is diverticulitis with local suppuration."

Case 2.—A. W., a female aged 70, was first admitted on July 8, 1950, complaining of pain in the right iliac fossa of sudden onset, and of three days' duration. It was associated with anorexia, but not with nausea, vomiting, or bowel upset. On examination, a large, tender, fixed mass was found in the right iliac fossa, and was diagnosed as an appendix abscess. This resolved under conservative treatment, and the patient was discharged on July 15.

Barium enema performed five days later revealed no evidence of carcinoma or of multiple diverticula, but a small solitary diverticulum was noted projecting from the lateral surface of the cæcum just above the ileocæcal junction.

FIG. 119.—*Case* 3. Showing the appearances found at operation. The dotted line indicates the size and site of the fæcolith lying within the diverticulum and projecting into the lumen of the cæcum.

Three months later the patient was re-admitted for interval appendicectomy, having had no symptoms in the interim. At operation, the appendix was almost completely free of adhesions, and appeared normal. Many adhesions were found, however, surrounding a small diverticulum and binding it to the lateral wall of the large bowel. On being freed by sharp dissection, the diverticulum was shown to measure 2 × 2 cm. (*Fig.* 118), and to possess a wide mouth through which it could be readily invaginated into the lumen of the bowel. A few catgut sutures across its base sufficed to prevent its reappearance. The patient was discharged on the twelfth post-operative day. Histological examination of the appendix revealed only slight submucosal fibrosis and lymphoid hyperplasia.

This case is regarded as one of diverticulitis because the distribution of adhesions around the diverticulum indicated that it was the source of previous inflammation. It would have been quite unsuspected, and almost certainly overlooked at operation, had not the barium enema fortuitously revealed its presence.

Case 3.—F. B., a 20-year-old male, admitted on Oct. 11, 1950, gave a history of generalized abdominal pain, nausea, constipation, and increased frequency of micturition, of seven days' duration. On examination, a small tender mobile mass was felt in the right iliac fossa. The temperature was 99° F. and the leucocyte count 8000 per c.mm.

The diagnosis of 'appendix mass' was made, and conservative treatment advised. After two days, however, the patient was still complaining of pain, the pulse-rate was rising, and operation was undertaken. The cæcum and appendix were delivered, and were found to present the appearances shown in *Fig.* 119. What appeared to be the appendix consisted of three distinct portions :—

1. A distal portion, 2·5 cm. long, of the normal calibre and appearance of the appendix.
2. A middle, distended part, demarcated from the proximal part by a well-defined constriction.
3. A globular proximal part, 2·5 cm. in diameter, containing a hard stone which filled it, and projected into the lumen of the cæcum through a wide diverticular mouth.

The entire structure was diffusely, subacutely inflamed, and was removed along with the fæcolith by incision of the cæcal wall, the resulting defect being closed by two layers of sutures. The patient made a good recovery and was discharged on the eighth post-operative day.

PATHOLOGICAL REPORT (Dr. Lennox).—"The specimen is 70 mm. long ; 25 mm. have the appearance of the distal half of an ordinary appendix, but proximal to this the whole organ expands rapidly but smoothly to a diameter of 25 mm. The lumen of this bulbous portion is filled by thick, folded, mucous membrane. There is then a slight constriction, and proximal to this again is another bulbous area of similar diameter, in which a thin wall tightly grasps a 20-mm. calcified fæcolith.

FIG. 120.—*Case* 3, showing a longitudinal section through the appendix. (× 3.)

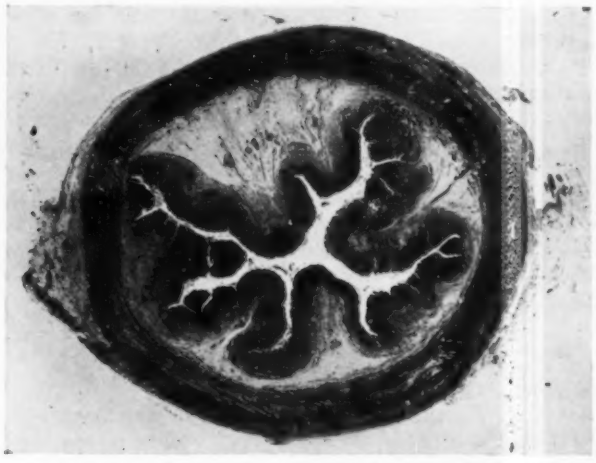


FIG. 121.—*Case* 3. Transverse section through the distal bulb, showing thick folded mucosa and complete longitudinal and circular muscle layers. (× 3.)

Surgical section has been made just beyond the greatest diameter of this stone.

"Histologically, the narrow *distal part* is undoubtedly appendix (*Fig.* 120). The *first bulb* is also, in spite of its size, appendix. The epithelium contains abnormal numbers of goblet cells, and the lamina propria, being thicker and more regular than usual, has some resemblance to colonic mucosa ; but Paneth cells, lymphoid tissue, and a continuous layer of longitudinal muscle label

FIG. 122.—*Case* 3, showing section through the diverticulum. (× 6.)

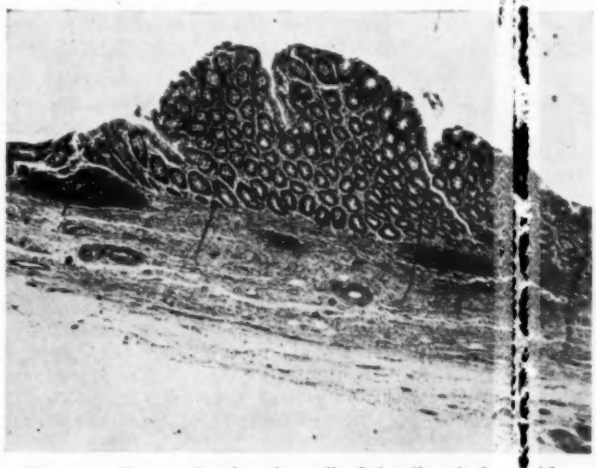


FIG 123.—*Case* 3, showing the wall of the diverticulum with mucosa of colonic type. (× 42.)

this as certainly appendix. This generalized enlargement is probably congenital : it is certainly not a mucocele. (*Fig.* 121.)

"The nature of the *second bulb*, that containing the stone, is much less certain, because the whole wall is thin and disorganized (*Fig.* 122). The epithelium is definitely colonic (*Fig.* 123), with no Paneth cells ; but there is more lymphoid tissue than is usual in the colon. There is no longitudinal muscle layer, but even the circular layer is discontinuous. On the whole I think this second bulb is colon. If so, it must represent a diverticulum of the colon, from the summit of which arises an abnormal appendix. Probably this has been a

conical cæcum, with a less clear distinction than usual between cæcum and appendix. The original conical shape may have been modified by fibrosis around the stone."

SUMMARY

1. Three cases of cæcal diverticulitis are described.

2. The literature is briefly reviewed and the clinical and pathological features discussed.

I have to thank Drs. C. V. Harrison, B. Lennox, and K. Weinbren, of the Department of Pathology of the Postgraduate Medical School, for the pathological opinions quoted. I am also indebted to Miss Helen Wilson for her illustrations; and to Mr. E. V. Willmott, A.R.P.S., for the photomicrographs.

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A CASE OF TRAUMATIC URÆMIA

BY H. N. GREEN, H. B. STONER, H. J. WHITELEY, AND D. EGLIN

NO. 2 BRITISH TRAUMATIC SHOCK TEAM R.A.M.C. (1945–6); DEPARTMENT OF PATHOLOGY, UNIVERSITY OF SHEFFIELD

DURING the recent war a team was organized by the Medical Research Council and the War Office to investigate traumatic shock in battle casualties from a biochemical standpoint. The results of these investigations have been described elsewhere (Green, Stoner, Whiteley, and Eglin, 1949). During the course of that work a case of traumatic uræmia was seen of sufficient interest to warrant separate publication despite the fact that many such cases have now been recorded (Lauson, Bradley, and Cournand, 1944; Parsons, 1945; Darmady, 1947).

CASE REPORT

The patient was a well-built young man (aged 21) with a penetrating shell wound of the left thigh. This wound had been inflicted eight hours before admission, by which time he showed the classical symptoms of traumatic shock. His clinical state deteriorated still further between admission and operation, probably as a result of continued venous hæmorrhage from the wound. Clinically there was no damage to the larger arteries of the limb as judged by the temperature of the wounded leg and the pulsation in its peripheral vessels.

AT OPERATION.—The femoral vein was found to be almost completely divided and the arteria profunda femoris with its accompanying vein was torn. The bleeding from these and many smaller vessels was arrested with some difficulty. During the operation the patient's condition was very grave and the blood-pressure could not be recorded in the arm. Throughout the operation the circulation through the damaged leg appeared to be satisfactory and, indeed, its temperature was somewhat higher than that of the supposedly normal right leg. A reproduction of the case sheet (*Fig.* 124) shows the site of injury and the changes in the oral temperature, blood-pressure, and pulse and respiratory rates.

After the operation his condition improved, but later the same day it was clear that all was not well. He remained far more drowsy than one would have expected and changes occurred in the unwounded right leg. The right foot became cold and the small area of discoloration around the external malleolus, first noted at the operation, extended down over the dorsum of the foot. Pulsation was felt in the femoral artery on this side, but none below the level of the knee. By the following day these clinical signs had disappeared and pulsation returned in the posterior tibial artery. At this time there was a patchy cyanosis of the skin of the hands.

The patient was now very ill and rapidly passed into a state clinically resembling that seen in the 'crush syndrome'. The blood-pressure rose and the urine output diminished. His condition became worse (*Table I*), and he died in uræmia at the end of four days.

BIOCHEMICAL FINDINGS.—The methods used and their interpretation have been previously described (Green et al., 1947, 1949, 1950). In this case the inorganic phosphate, adenosine equivalent, and pentose levels were determined on an acetone precipitate of plasma. The results are shown in *Table I*.

On admission there was a marked anæmia which was partially corrected by blood transfusion. The inorganic phosphate, adenosine equivalent, and pentose levels may be compared with results obtained in a control group of 27 young normal males (Green et al., 1949) which were as follows: inorganic phosphate 2·41 mg. per 100 ml. (S.D. = 0·5); adenosine equivalent 11 μg. per ml. (S.D. = 3); total pentose 2·55 mg. per 100 ml. (S.D. = 0·37); phosphorylated pentose 2·19 mg. per 100 ml. (S.D. = 0·30). From the point of view of these fractions the blood-picture on admission was essentially normal except for the greatly raised adenosine equivalent. On the following day the blood N.P.N. level was found to be above the normal limits, and this continued to rise for the remainder of his illness. The plasma α-amino-nitrogen level showed no significant alteration. The

plasma inorganic phosphate level was raised, and although the adenosine equivalent fell progressively, the phosphorylated pentose fraction remained high whilst the level of the total plasma-pentose rose progressively.

Examination of the urine on the final day of the illness showed that it contained a heavy cloud of albumin, with many coarse granular casts in the deposit, together with a few red cells. Under the conditions in which we were working it was not possible to test for the presence of myohæmoglobin.

Table I.—Clinical Course and Biochemical Findings in the Blood of the Patient

Time	Observations	Hb Per Cent (Sahli)	Ht. Per Cent	Blood N.P.N. Mg. Per Cent	Plasma α-amino N. Mg. Per Cent	Plasma Inorganic P. Mg. Per Cent	Adenosine Equivalent μg./ml. Plasma	Plasma Pentose Mg. Per Cent	
								Total	Phosphorylated
1945									
April 5,	Morphine gr. ¼, 3 pints plasma given forward								
21.15	1 pint plasma								
21.30	1 pint plasma								
22.15	Respirations deep. Extremities warm but nose cold. Rigor started after transfusion here. Veins of neck neither palpable nor visible. Pale. Nausea, no vomiting. Thirst ++. Tongue dry but not coated. Had water since injury. Last meal breakfast 07.00 hrs. No cyanosis. Mucous membranes pale. Continued to lose blood before operation								
	Blood specimen	40	20	—	—	1·85	20	2·24	1·82
April 6,									
01.30	Operation. 1 pint blood								
02.20	1 pint blood								
02.30	2 pints blood								
10.50	General condition greatly improved. Can be roused though very drowsy. Skin slightly flushed. Peripheral circulatory return only moderate. Pulse rapid, with fair volume. Right foot cold with area of discoloration extending from malleoli down to the heads of the metatarsals. No circulatory return from here. Pulsation felt in femoral artery. Left foot warm								
14.20	Blood specimen	75	35	71·4	4·72	4·61	18	4·28	2·67
April 7									
12.00	Still thirsty. Slight icterus of conjunctivæ. Tongue dry and coated. Slight malar flush. Hiccup +. Right foot now quite warm. Discoloration has disappeared. Pulsation present in right post-tibial artery. Sensation present with full movement. No movement in left foot, but sensation present. Circulatory return from hands very poor, with patchy cyanosis								
	Blood specimen	80	34	82·0	4·76	—	12	4·95	2·33
April 8									
12.00	Blood specimen	—	—	167·0	—	—	—	—	—
15.40	Drowsy. Restless. 'Uræmic odour' to breath. Respirations deep and sighing. Sweating profusely								
April 9									
14.10	Confused and restless. Not sweating. Still hiccuping								
	Blood specimen	65	28	222·0	4·46	—	8	7·96	2·61
22.10	Died								

Autopsy Findings (performed thirteen hours after death).—There was an entrance wound on the upper and medial aspect of the left thigh and an associated exit wound on the posterior part of the thigh slightly below the level of the entrance wound. The tract connecting the two wounds was lined by a large quantity of soft dark red muscle and passed near the femoral vessels. The artery was undamaged, but the vein was almost completely severed except for a narrow strip of tissue. The left femoral artery and the vessels of the right leg were patent throughout their course. Surrounding the tract and extending through the muscles of the thigh were numerous areas, up to 1½ in. in diameter, of pale muscle standing out in marked contrast to the surrounding normal muscle. The femur was undamaged.

Each pleural cavity contained about 2 oz. of straw-coloured fluid, and the lungs were bulky and very œdematous with areas of dark purple consolidation, especially in the lower lobes. The heart and great vessels appeared normal, as did the brain and meninges.

The spleen was firm, large, and dark red in colour. The liver had a well-marked pattern and contained numerous irregular buff zones about ¼ in. in diameter with ill-defined edges. Each kidney weighed 8 oz. The capsule stripped and the cortex was swollen and very pale whilst the medulla was congested and showed marked radial striations (*Fig.* 125).

Microscopical examination of the kidneys showed the glomerular tufts to be shrunken and bloodless (*Figs.* 126, 128) with numerous round, pink aggregates about the size of an erythrocyte in the capsular space. Occasional cortical arterioles were blocked by ante-mortem thrombi. No cubical changes in the cells lining Bowman's capsule were observed. There was an even, widespread dilatation

of the convoluted tubules, with flattening of the lining cells (*Fig.* 127). The tubules contained amorphous pink material which was at times granular. Faintly pigmented casts were occasionally seen in the second convoluted tubules and in the collecting tubules there were numerous pigmented, clear, or granular casts without any apparent damage to the lining cells (*Fig.* 128). These casts were neither large enough nor sufficiently widespread for the oliguria to be attributed to the tubular blockage. The casts contained no free iron and gave no reaction after treatment with nitric-acid–alcohol mixture. No lesions were observed at the junction of cortex and medulla. The medulla, in contra-distinction to the cortex, was markedly congested (*Figs.* 125, 126).

Further microscopical studies showed central congestion and necrosis in the liver. Marked congestion, œdema, and some areas of hæmorrhage were seen in the lungs (*Fig.* 129), but there was no evidence of fat embolism. Muscle from the wound showed necrosis and pyogenic infection. Muscle taken from the pale areas of the leg was not necrotic.

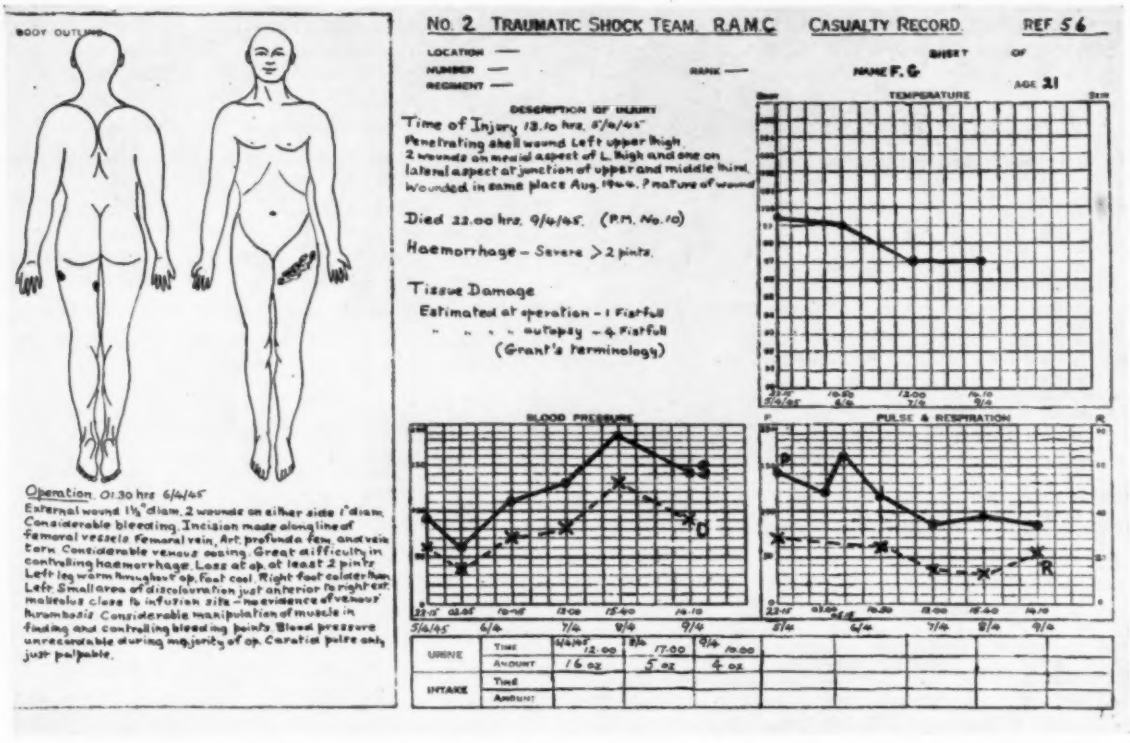
BODY OUTLINE
NO. 2 TRAUMATIC SHOCK TEAM. R.A.M.C.
CASUALTY RECORD
REF 56
LOCATION
NUMBER
REGIMENT
RANK
NAME F. G.
AGE 21
DESCRIPTION OF INJURY
Time of Injury 13.10 hrs. 5/4/45
Penetrating shell wound Left upper thigh.
2 wounds on mesial aspect of L. thigh and one on lateral aspect at junction of upper and middle third.
Wounded in same place Aug. 1944. ? nature of wound
Died 22.00 hrs. 9/4/45. (P.M. No. 10)
Haemorrhage – Severe >2 pints.
Tissue Damage
Estimated at operation – 1 Fistfull
" " " autopsy – 4 Fistfull
(Grant's Terminology)
TEMPERATURE
BLOOD PRESSURE
PULSE & RESPIRATION
Operation. 01.30 hrs 6/4/45
External wound 1½" diam. 2 wounds on either side ¼" diam.
Considerable bleeding. Incision made along line of femoral vessels. Femoral vein, Art. profunda fem. and vein torn. Considerable venous oozing. Great difficulty in controlling haemorrhage. Loss at op. at least 2 pints.
Left leg warm throughout op. Foot cool. Right foot colder than Left. Small area of discolouration just anterior to right ext. malleolus close to infusion site – no evidence of venous thrombosis. Considerable manipulation of muscle in finding and controlling bleeding points. Blood pressure unrecordable during majority of op. Carotid pulse only just palpable.
URINE
TIME
AMOUNT
INTAKE
TIME
AMOUNT
6/4 7/4 8/4 9/4
12.00 17.00 10.00
16 oz 5 oz 4 oz

FIG. 124.—Reproduction of case sheet giving details of wound and operation with the changes in oral temperature, blood-pressure, pulse and respiratory rate, and urine output.

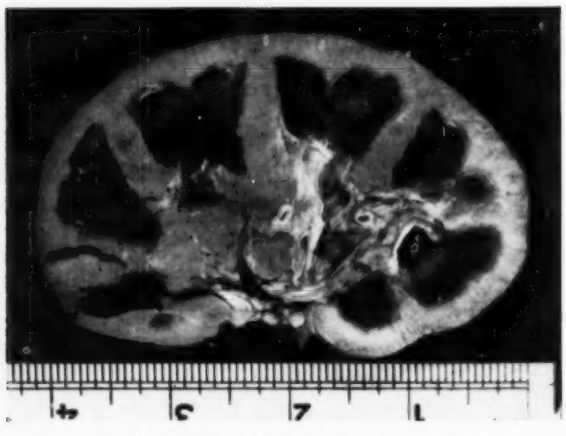

FIG. 125.—Photograph of kidney showing contrast between medulla and cortex and the striations in the medulla.

DISCUSSION

The short course of this case suggests that death was not entirely due to renal failure. The severe hæmorrhage and the pulmonary œdema no doubt made major contributions to the final issue. There was no evidence of incompatible transfusion. The mild rigors and slight icterus observed were common in these patients transfused with reconstituted plasma and stored Group O blood. Nor was there any evidence of clostridial infection. Chemical factors from ischæmic muscle may have played a part, and the possible significance of the chemical changes from this point of view have been discussed in the previous paper (Green et al., 1949).

Interest centres chiefly about the vascular changes which occurred. Arterial spasm appears the most likely explanation for those observed in the unwounded leg. Trueta and others (1947) have described similar changes after the application of a tourniquet to one hind limb of a rabbit. The areas of pale muscle throughout the wounded thigh closely resembled those reported by Le Gros Clark and Blomfield (1945) after bullet wounds of the leg in rabbits; these they attributed to arteriolar spasm. The altered vascular pattern of the kidney with its cortical ischæmia and medullary congestion also resembled the circulatory changes described in animal

kidneys after limb ischæmia by Trueta and his colleagues (1947) and which were shown by them to be due to sympathetic nervous stimulation. It is very likely that the cortical ischæmia and anoxia resulting from this redistribution of the blood played a major part in the production of the renal damage of this case.

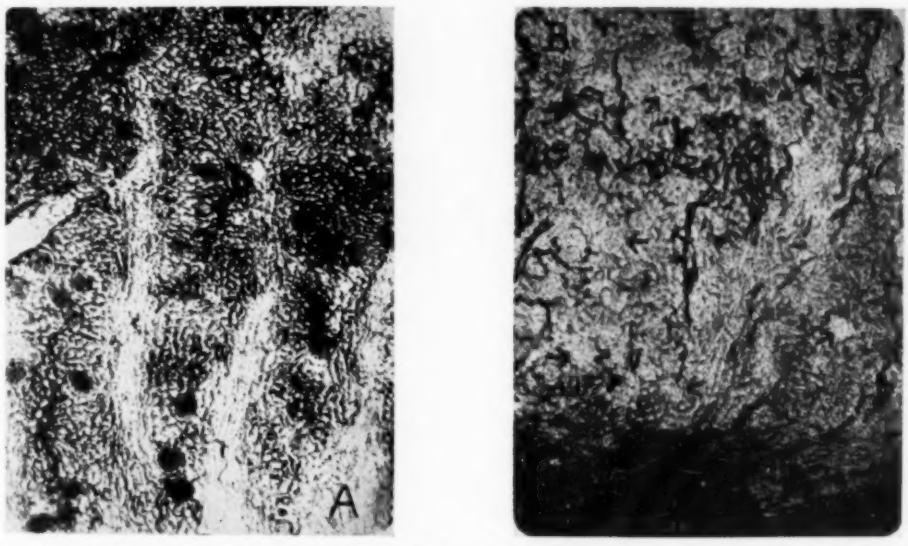

FIG. 126.—Sections (300μ) of kidney stained by Pickworth's method. A, Normal kidney showing the glomeruli well filled with blood and darkly staining (× 12·5). B, Patient's kidney showing medullary congestion and ischæmia of the glomeruli, indicated by arrows (× 12·5).

A further interest lies in the similarity between the pathological appearance of these kidneys and that in cases of the 'crush syndrome' (Dunn, Gillespie, and Niven, 1941; Morison, 1941; Mayon-White and Solandt, 1941; Glen, 1941; Bywaters and Dible, 1942; Caplan and Dunkerley, 1945). Similar, though less well-marked, renal lesions occurred in 5 other fatal cases of our series. This similarity has been observed before in other fatal cases of traumatic uræmia (*see above*) and supports the view that there is no essential difference between the renal lesion in the two syndromes. The renal lesion is usually further advanced in the 'crush syndrome', but this may be related to the longer survival time usually seen in these cases uncomplicated by external hæmorrhage and multiple wounds.

With regard to the mechanism of the lesion, the general opinion (Bywaters and Popjak, 1942; Bing, 1943; Scarff and Keele, 1943; Eggleton et al., 1943; Eggleton, 1944; Bywaters and Stead, 1944; Badenoch and Darmady, 1947; Harrison et al., 1947) is that it occurs through the interplay of two factors—renal anoxia and toxic metabolites. The former may

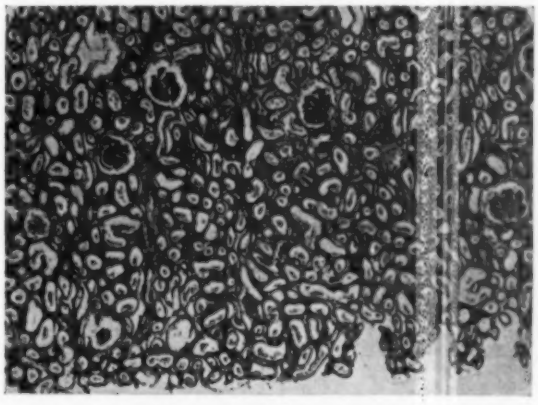

FIG. 127.—Section of the kidney stained with hæmatoxylin and eosin showing widespread tubular dilatation, and casts. (× 25.)

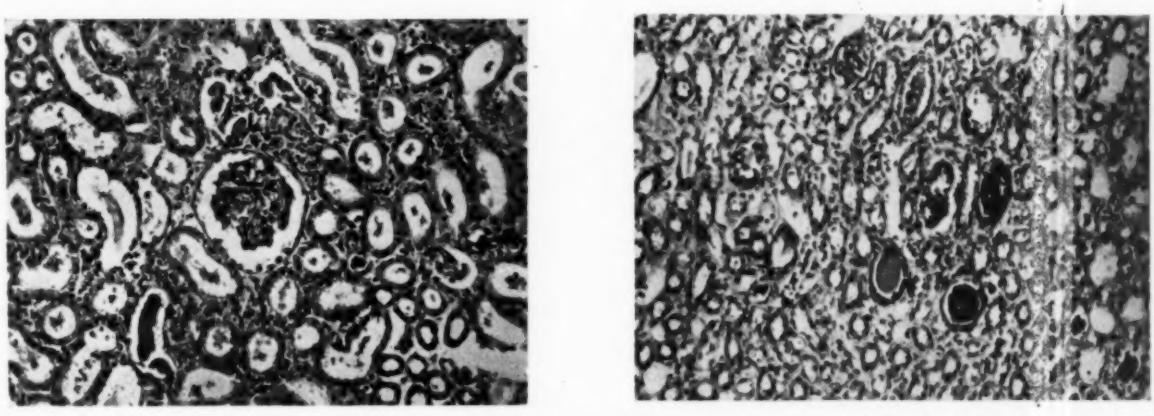

FIG. 128.—Sections of the kidney stained with hæmatoxylin and eosin showing shrunken glomerulus and dilated tubules with casts. (× 60.)

obviously arise in several ways, e.g., by vascular spasm, as is probable in this case. The identities of the latter are still in doubt although myohæmoglobin is certainly an important factor. Many attempts have been made by ourselves (Green and

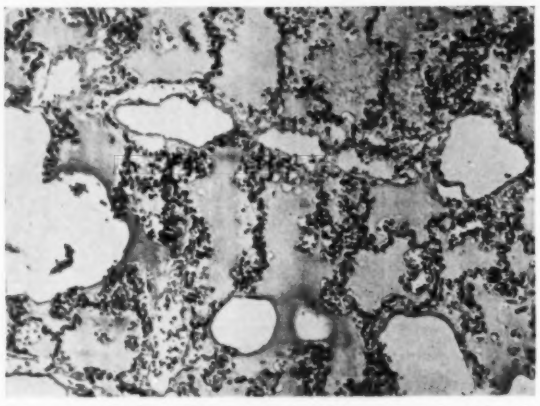

FIG. 129.—Section of lung stained with hæmatoxylin and eosin showing pulmonary œdema. (× 60.)

Stoner, 1950) and others (*see above*) to reproduce the histological picture of the 'crush syndrome' kidney in experimental animals, but never with complete success, and it is quite possible that this post-traumatic renal picture is peculiar to man.

SUMMARY

1. The clinical, biochemical, and pathological features of a fatal case of traumatic uræmia have been described.

2. A feature of the case was the widespread vascular spasms which occurred. The possible role of this in the pathogenesis of the condition is discussed in the light of various animal experiments reported in the literature.

Our thanks are due to the Commanding Officer and surgeons of 101 British General Hospital for permission to investigate this case, and to Dr. M. Bielschowsky for the pentose determinations.

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* The full protocols of this work, under the title "Biological Studies on Purine Compounds. Their Role in the Reaction to Injury" (Green, H. N., Bielschowsky, M., and Stoner, H. B., 1947) have been deposited at the Library, National Institute for Medical Research, Hampstead, London, N.W.3, where they are available for consultation. In addition, some of the material has been published in scientific journals and further observations continue to appear.

SHORT NOTES OF RARE OR OBSCURE CASES

INVERSION OF THE APPENDIX

BY PAUL HICKINBOTHAM, LEICESTER

SOMETHING over 100 cases of intussusception or complete inversion of the appendix have now been reported in the literature, and very adequate reviews of the condition have been published by McSwain (1941), K. Fraser (1943), and others. It is, therefore, intended only to present here a report of a case showing several unusual features.

CASE REPORT

Miss E. M. S., aged 18, was quite well until Dec. 26, 1949, when she started having right-sided abdominal aching pains, with occasional bouts of central abdominal colic. The following day she had diarrhœa, passing eight or nine loose motions; these contained considerable quantities of dark-red blood, amounting to something over a pint during the 24 hours. Coincidentally with the diarrhœa she started vomiting, and during that day she vomited everything she took. After a day of this the diarrhœa and vomiting ceased, but her pain persisted as a right-sided ache, and she was admitted to hospital on Jan. 4, 1950.

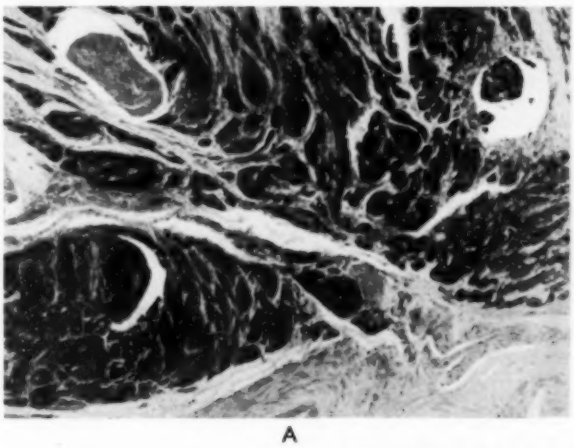
At that time she had a temperature of 98·6°, pulse 88, and her colour was good. She was tender in the right abdomen, but there was no guarding and no mass could be felt. Rectal examination revealed fluid red blood on the finger. A blood examination showed a hæmoglobin of 72 per cent and a leucocyte count of 8200.

During the next week she was well apart from occasional bouts of aching in the right iliac fossa; she passed

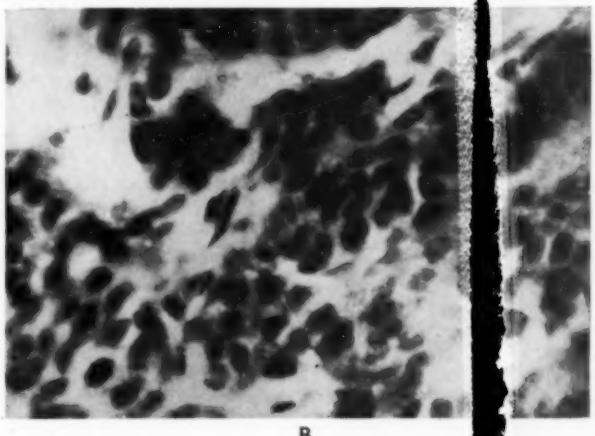
no more blood and the diarrhœa ceased. Her temperature varied up to 99·2°. Sigmoidoscopy on Jan. 12

FIG. 130.—Radiograph following barium enema, showing well-defined filling defect in lateral wall of cæcum.

revealed no abnormality in the rectum or lower colon. A barium enema, however, showed a smooth well-defined filling defect in the lateral wall of the cæcum (*Fig.* 130).



A



B

FIG. 132.—Photomicrographs of section through nodule. (A, × 33; B, × 250.)

The possibility of growth, benign or malignant, ileocæcal chronic inflammatory lesions, and intussusception were considered. Without having been able to make a definite diagnosis it was decided to explore the abdomen, and this was done on Jan. 26. The cæcum was œdematous and injected, and at the expected site of the appendix there was merely a dimple with the appendix mesentery entering it; on palpating the cæcum, the appendix could then clearly be felt inside. Attempts to squeeze it out having failed, the mesentery was divided and the appendix delivered and removed by incising the cæcal wall around its base. The resulting cæcal defect was then closed in the usual way. She made a satisfactory convalescence.

The specimen (*Fig.* 131) showed the appendix completely turned inside out; the mucosa was very engorged, and at the tip there was a solid nodule about the size of a pea, whitish in colour. Histologically this proved to be an argentaffin tumour (*Fig.* 132).

DISCUSSION

The interest of this case is twofold: the pathology and the diagnosis. As regards the former, this is the only recorded case, as far as I am aware, of an

FIG. 131.—Photograph of completely inverted appendix. (× ⅔.)

argentaffin tumour at the tip of an inverted appendix, and presumably the cause of the condition. In other cases a fæcolith impacted in the appendix, worms, and in five cases polyps or papillomatous tumours at or near the proximal end of the appendix have been suggested as causes of the commencement of intussusception.

Looking back on the question of diagnosis, a more vivid awareness of the condition would, I think, have simplified the problem. The presenting features of melæna, aching in the right iliac fossa, and a cæcal filling defect, in a young healthy patient with a normal white count, did not fit any of the other diagnoses we had in mind: she was too young and well, and the onset too sudden and painful for growth; the clear-cut localized filling defect in the lateral cæcal wall was not right for the chronic inflammatory group; and the absence of obstructive signs and symptoms ruled out the ordinary forms of intussusception.

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NEURINOMA OF THE FACIAL NERVE SIMULATING A PAROTID TUMOUR

By J. S. H. WADE, M.C.

SENIOR SURGICAL REGISTRAR, UNITED CARDIFF HOSPITALS

A NEURINOMA (*syn.*, schwannoma, neurilemmoma) of the seventh cranial nerve is a rare occurrence. In the majority of cases described the tumour involved the nerve in the facial canal, and the patient came under the care of the ear, nose, and throat surgeon (Altmann, 1935, 1937; Tremble and Penfield, 1936; Williams and Pastore, 1939; Roberts, 1943; Bogdasarian, 1944; Kettel, 1946). In one previous case report mentioned by Willis (1948) the nerve was apparently involved in its course through the parotid salivary gland.

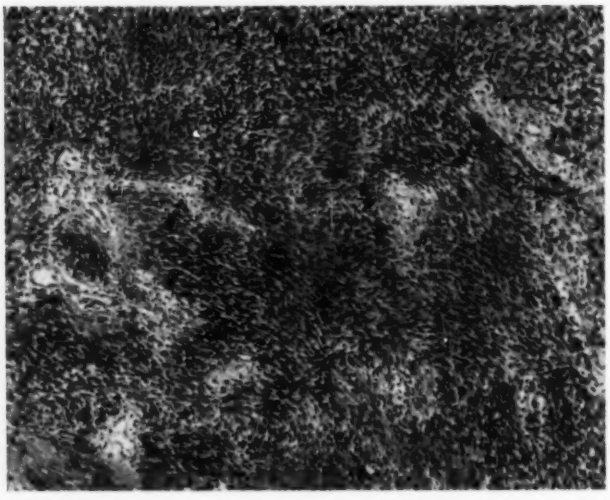

FIG. 133.—Microphotograph of a section of the tumour. (× 68.)

In the case described below a neurinoma of the facial nerve, accompanied by a facial paralysis, closely resembled a parotid tumour, and the diagnostic problem was further confused by the presence of a long-standing aural discharge and deafness on the same side.

CASE REPORT

A woman, aged 52, was admitted to the Cardiff Royal Infirmary under the care of Mr. J. O. D. Wade on Dec. 30, 1949, complaining of a painless lump in the left parotid region of eight months' duration which had slowly increased in size. Since she was one year old she had had an intermittent discharge from the left ear, and had always been a little deaf on that side. Two years previously she had first noticed a persistent watering of the left eye accompanied by a weakness in closing it. During the last eight months the muscular weakness had spread gradually all over the left side of the face, and this lump had made its appearance.

ON EXAMINATION.—There was a rounded swelling situated deep in the left parotid gland, about 1½ in. in diameter, and of a firm consistency. It was freely mobile and there were no enlarged cervical lymph-nodes. She had a complete facial paralysis and was slightly deaf on the left side. Clinically, but for the facial paralysis, the swelling resembled a benign mixed salivary tumour.

Diagnosis.—The differential diagnosis was a malignant mixed salivary tumour on the one hand and a benign mixed salivary tumour accompanied by otitis media on the other. She was referred to Mr. R. D. Owen, Surgeon to the Ear, Nose, and Throat Department, who reported that, while meatitis was present, there was no middle-ear disease, and the ear could be excluded as the cause of the parotid swelling and the facial paralysis. In view of this report it was decided to excise the tumour.

AT OPERATION.—The superficial part of the gland was normal and was dissected backwards, some branches of the facial nerve being identified and preserved. The tumour lay between the superficial and deep lobes of the gland; it was soft, apparently encapsulated, and no connexion between it and the facial nerve was noted; indeed, neither the trunk nor the main branches of the nerve were demonstrated. On attempting to dissect it out the capsule ruptured, and a gelatinous substance exuded. The contents of the tumour were therefore removed piecemeal and an attempt made to excise the capsule. It was considered that the tumour was probably a mixed salivary tumour undergoing cystic degeneration, and that its removal was surgically incomplete; however, in view of the doubt as to the diagnosis, it was thought best to postpone a more radical excision, with the probability of extensive damage to the facial nerve, until histological examination.

Histology.—The pathologist's report was: "The section shows a neurinoma (schwannoma)." (*Fig.* 133.)

POST-OPERATIVE COURSE.—Correlating the histological report with the clinical and operative findings, it was concluded that the neurinoma arose from the main trunk of the facial nerve immediately proximal to its division into its two main branches.

In deciding upon further treatment the following factors were taken into account: the age of the patient; the possibility of a recovery of nerve function; the benign course and slow growth of the tumour; and the satisfactory results obtained by a similar gutting operation in cerebello-pontine tumours. Further operation was therefore discarded in favour of a careful follow-up, and in view of the known radio-resistance of the tumour, radiotherapy was considered to be valueless.

When last seen, in April, 1951 (fifteen months after the operation), there was no evidence of recurrence, and no sign of recovery of the facial paresis.

I am indebted to Mr. J. O. D. Wade for his advice in the care of the patient and in the preparation of this paper.

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ADENOMA OF THE DUODENUM

By CHARLES NOON, Norwich

Neoplasms of the duodenum are of sufficient rarity to be reported.

CASE REPORT

The patient complained of periodic attacks of epigastric pain for three years. He had had to give up work from time to time for two to three weeks. The pain was dull and aching in character. Food did not relieve the pain, but occasionally made it worse. He had nausea, but no vomiting. His appetite was good between the attacks. The symptoms were increased by any worry or anxiety. He had not lost weight. He complained of no other symptoms. He looked fairly well, was slim but of poor physique, with a nervous temperament. He had a slight tremor of his hands and tongue.

Physical Signs.—There was no abdominal distension or tumour, and respiratory movements were normal. He referred the pain to the right side of the abdomen, over the upper part of the right rectus muscle. There was tenderness but no rigidity in this area. Nothing else abnormal was detected in the abdomen.

X-ray Examination of the Abdomen.—The X-ray report was as follows :—

Region : Stomach and duodenum—barium meal.

Preliminary screening of the chest reveals no abnormality.

Œsophagus normal.

Stomach : A trifle low, no defects seen, no tenderness on palpation.

Duodenum :—

Film 1 : The duodenal cap fills evenly. It is small, and there is some tenderness on palpation in the vicinity.

Film 2 (taken an hour later) : The stomach is nearly empty. There is a large filling defect to be seen in the second part of the duodenum. The defect is chiefly on the right side. This is the site of tenderness when palpated.

Film 3 (taken one hour later than Film 2) : The stomach is now empty. The filling defect is not so clearly marked.

Conclusion : The stomach shows no abnormality, the duodenal cap is small but is regular in outline. There is a large filling defect in the second part of the duodenum. This is tender on palpation. Appearance is suggestive of a new growth.

Operation (May 13, 1944).—The abdomen was opened above the umbilicus to the right of the midline. No gastric lesion was discovered. There were a few adhesions round the duodenum. Nothing abnormal was detected in the first part, but a soft tumour was felt in the second part, which gave the sensation of a soft lipoma. The duodenum was mobilized and opened on the anterior surface away from the tumour. The tumour was sessile rather than pedunculated—that is, the base was broad. It was attached to the anterior and right lateral wall of the duodenum and was found to be clear of the orifice of the common bile-duct. It was excised with a clear margin of about ¼ in. The vertical incision in the duodenum was closed transversely with two layers of sutures.

Subsequently the patient made satisfactory progress and has remained well for six years.

Histological Report.—

Macroscopical Appearance.—It is a well-defined sessile type of tumour which is growing from the mucous membrane. There is no infiltration of the wall of the gut.

Microscopical Appearance.—The section shows a columnar-celled adenomatous polyp. In the material examined there is no evidence of malignancy. The second part of the duodenum, especially near the ampulla of Vater, is the usual site of such tumours.

A CASE OF INTRALOBAR SEQUESTRATION OF THE LUNG ASSOCIATED WITH AN ABNORMAL PULMONARY ARTERY

By C. McDOWELL, DOUGLAS ROBB, J. R. HINDS, and ROWAN NICKS

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This case is reported in detail chiefly because the diagnosis was made tentatively before operation. The study presented by Pryce, Holmes-Sellors, and Blair (1947) had familiarized us with the condition. The arterial abnormality probably falls into their third class of an aberrant artery confined to the sequestrated mass. An additional point, to us, is the occasional association of an abnormal pulmonary artery of this kind with a pulmonary arteriovenous aneurysm. In Watson's (1947) case, ligation of the abnormal vessel was the only step necessary to cure the condition.

CASE REPORT

The patient, J. W., a Maori boy aged 8 years, was referred from a rural tuberculosis clinic by Dr. C. H. King with a diagnosis of cystic bronchiectasis. It was impossible to gain a clear picture of the early stages of the child's illness.

It would seem, however, that in August, 1946, he developed a right-sided spontaneous pneumothorax. This is confirmed by a radiograph taken on Aug. 24 of that year. This film (*Fig.* 134), though of poor quality, shows a partial collapse of the right lung. The apex of the lung is seen as a radiolucent ' cap ' above a massive opacity occupying the lower part of the lung. This basal opacity has a clear-cut sharply bowed upper margin. In the upper and lateral parts of this opaque mass there are some ill-defined, more radiolucent areas suggesting cystic changes in an otherwise consolidated lung base.

A second film taken on Sept. 5 (*Fig.* 135) fails to show any residual pneumothorax. The lung field in the upper third of the right hemithorax appears normal, but the lower two-thirds are still occupied by a dense opacity relieved, as before, by a number of more or less rounded relatively radiolucent areas in the upper and outer parts. A further film on Jan. 31, 1947 (*Fig.* 136), shows some clearing of the basal opacity, which no longer has a clear-cut upper margin. The appearances are now suggestive of a confluent basal bronchopneumonia

associated with some patchy emphysema. The lesser fissure is seen as a broad linear opacity at the level of the third anterior costal cartilage.

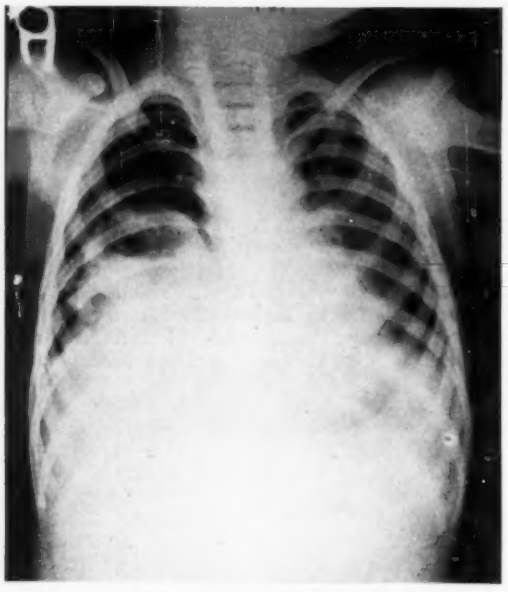


FIG. 134.—August, 1946. Partial collapse of right lung. Apex appears as a radiolucent cap to level of about 5th rib posteriorly. Massive opacity from level of 7th rib posteriorly downwards, with cystic spaces.

He was admitted to Green Lane Hospital on April 20, 1948, with a history of productive cough over a period of eleven months, but in all probability his cough really began in August, 1946. Expectoration was neither profuse nor offensive. Physical examination showed a

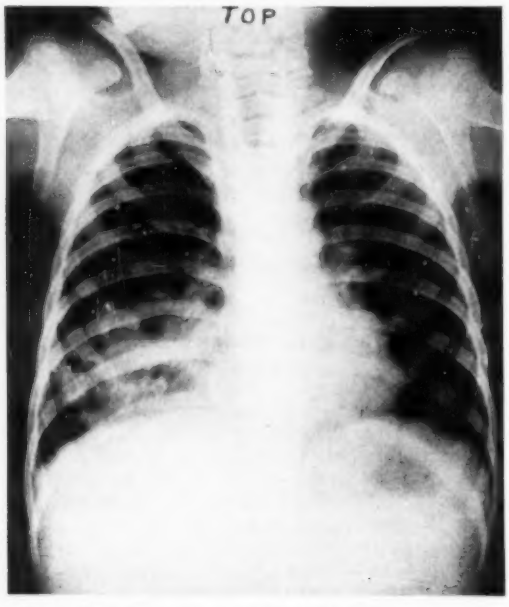


FIG. 136.—January, 1947. The basal opacity no longer clearly defined above. Appearance suggests confluent bronchopneumonia with patchy emphysema.

moderate pigeon-breasting with impairment, reduced air entry, and moist sounds at the right base posteriorly. He had slight but definite clubbing of the fingers. Repeated sputum examinations were negative for *M. tuberculosis*. Mantoux test was negative to 0·005 mg. P.P.D. The postero-anterior film on admission was unchanged, resembling that shown in *Fig.* 136, but a right

FIG. 135.—September, 1946. No residual pneumothorax. Lower two-thirds of lung field on right side still opaque with cystic spaces.

lateral film (*Fig.* 137) showed that the abnormal shadowing was limited to the posterior basal part of the lung.

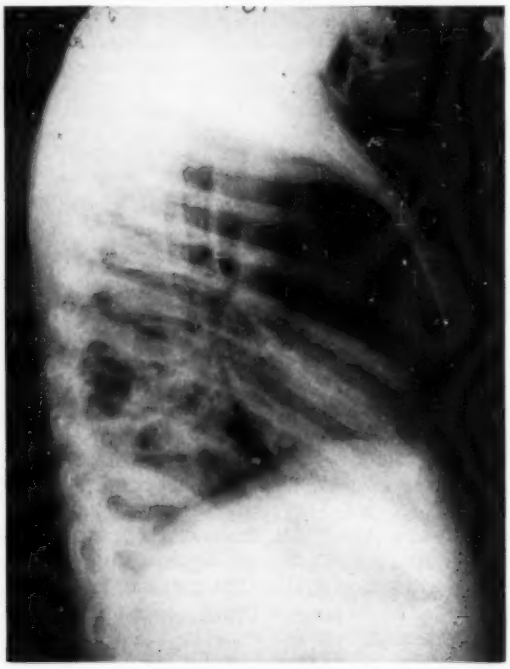


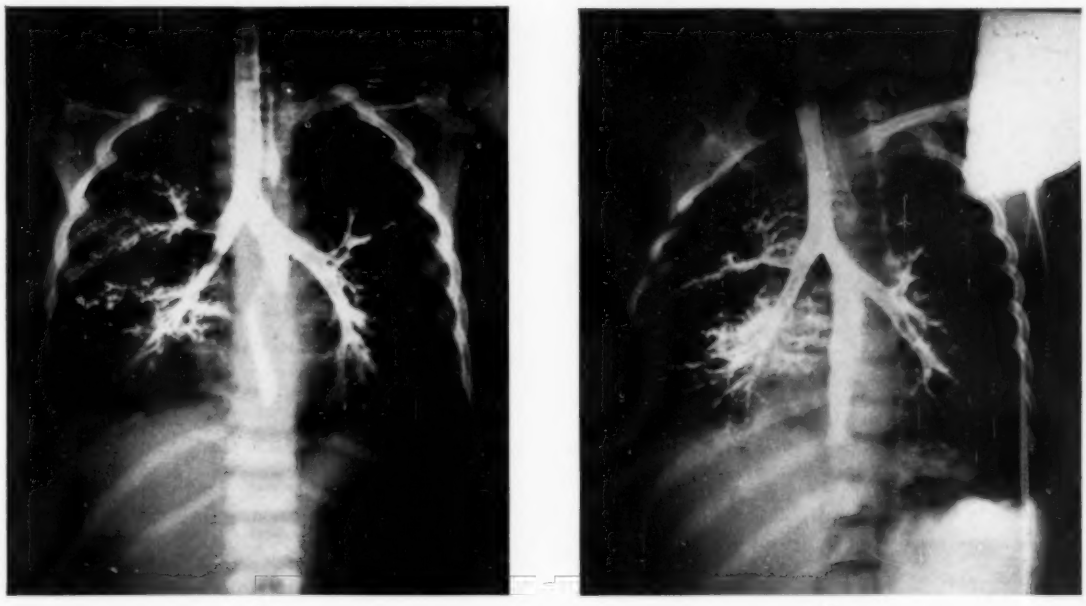
FIG. 137.—April, 1948. Abnormal shadowing is limited to posterior basal part of the lung. Postero-anterior film resembles *Fig.* 136.

Although children of 8 years or even younger will usually, in our experience, co-operate in endotracheal bronchography under local anæsthesia, we had in this case to resort to a general anæsthetic and the films are less

than satisfactory. The postero-anterior film (*Fig.* 138 A) and the semi-oblique film (*Fig.* 138 B) appear, however, to show a more or less normal right bronchial tree having little or no connexion with the posterior basal part of the lung. The upper-lobe bronchi are well filled. The middle-lobe bronchus and its two main subdivisions are defined, but are displaced upwards and outwards. The apical segment of the lower lobe shows some alveolar filling. The lower-lobe bronchus then divides into three main branches, but the posterior basal branch is displaced forwards and laterally. It is not possible to define a cardiac bronchus.

We were faced, then, with a partly cystic, suppurative condition of the right lung which, with the possible exception of the minor cardiac segment, was not the site for productive cough in the absence of demonstrable bronchiectasis and also for the gradual reduction in extent of the manifestly diseased area which is now comparable to a multilocular empyema with bronchopleural fistula permitting some drainage or partial air replacement. The fistulous passage was presumably small, for no lipiodol entered the diseased area.

OPERATION (right lower lobectomy, July 14, 1948).—Under intratracheal cyclopropane anæsthesia the chest was opened by resection of the seventh rib and 1 in. of the sixth rib at the angle. Light pleural adhesions bound the lower lobe to the chest wall. The main fissure was well defined, while the lesser fissure was partly obliterated. The middle lobe appeared to be atelectatic, but inflated freely when gas pressure was raised. The lower lobe



A B

FIG. 138.—Postero-anterior (A) and oblique (B) bronchograms showing a more or less norma bronchial tree on the right side having little or no connexion with the posterior basal region. Cardiac bronchus not identified.

of any demonstrable bronchiectasis. There were no features suggesting the presence of mediastinal, interlobar, or superficial empyema with bronchopleural fistula. Furthermore, a lesion which at one stage appeared to occupy more than half the right hemithorax was now reduced to bounds no greater than those of the posterior basal segment of the normal lobe, and yet there was no evidence of atelectasis of any major bronchopulmonary segment. We had not previously encountered any congenital or acquired cystic disease of the lung with comparable features, and this prompted a pre-operative diagnosis of intralobar sequestration. It was felt that the history and serial radiological findings might reasonably be explained on this basis. The sequence of events envisaged was as follows: a sequestration with independent blood-supply present in the base of the right hemithorax as a congenital anomaly; a gradual increase in size of the sequestrated mass associated with distension of the 'blind' bronchial tree by accumulated mucus; in August, 1946, an acute infection of the lower lobe spreading by contiguity to the sequestrated segment; as complications of this acute infection of the lung a spontaneous pneumothorax and the development of a fistulous communication between the normal bronchial tree and the distended bronchial pouches of the anomalous segment. This latter complication would explain the presence of irregular air-containing cysts within the main opacity. From this point onwards we have an explanation was obviously the site of a massive consolidation associated with some cystic degeneration. Exploration of the mediastinal aspect of the lower lobe showed an abnormal pulsating vessel fully 5 mm. in diameter coming off the aorta at a right angle opposite the body of the ninth thoracic vertebra. This vessel entered the base of the lower lobe through the thickened lower margin of the ligamentum latum.

Dissection of the hilum of the lower lobe was begun from the depths of the main fissure through a ring of enlarged lymph-nodes. The two normal branches of the pulmonary artery to the apical and basal segments of the lower lobe were defined and divided. These vessels were small for the size of the child. The bronchus to the lower lobe—also on the small side—was clamped beyond the take-off of the middle-lobe bronchus and divided. The lower pulmonary vein was found in the normal position and divided. This vessel was judged to be of normal size. The lower lobe was at this stage attached only by the broad ligament, with the aberrant vessel in its lower margin. The vessel was defined and divided between ligatures. This obviously arterial channel was not accompanied by any vein or veins. The return circulation from the lung must have followed the normal route through the pulmonary veins of the hilum. The bronchus was closed with four silk sutures and covered with a pleural flap. The upper and middle lobes inflated easily and the chest was closed with a

temporary underwater drain. Progress was uneventful and the patient left hospital in good condition.

THE SPECIMEN.—The right lower lobe was normal in size but of varying consistency. The greater part lying below and behind the hilum was indurated while the apical and anterior parts of the lobe were soft and spongy, suggestive of more or less normal lung tissue.

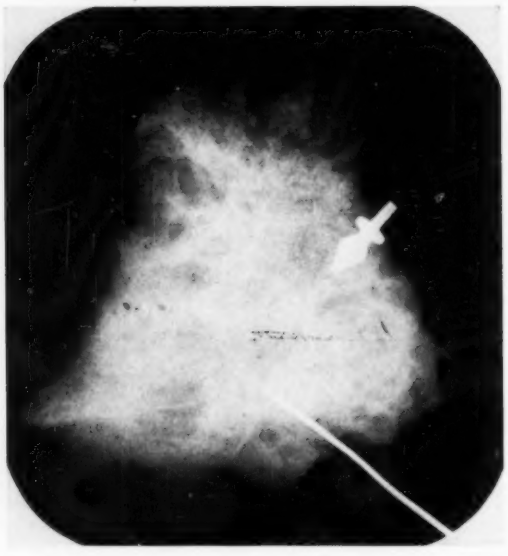


FIG. 139.—Anteroposterior view of excised lobe partially inflated, showing more or less normal architecture of the apex with large cysts at the junction of the radiolucent and opaque areas. Inflating nozzle in bronchus to lower lobe: probe lying in abnormal artery.

FIG. 141.—Right lateral view of excised lobe partially inflated, showing more or less normal architecture of apical and anterior portions with the sequestrated mass lying posteriorly. Large cystic spaces are shown in the subapical region. Nozzle and probe as in *Fig.* 139.

The hilum showed two distinct bronchial openings. The smaller—presumably the dorsal or apical bronchus—ran to the apical segment. The larger appeared to be the continuation of the lower-lobe bronchus. Inflation of either bronchus, in addition to partly distending the apical, lateral, and anterior parts of the lobe, showed a free escape of air from the other bronchus. In other words, there was a free communication between the apical and basal segments of the lower lobe. There were numerous minute lacerations of the visceral pleura preventing lasting distension of the lobe, but a moderate inflation was secured by sealing off all except one or two minor pleural defects in the hilar region. There was no demonstrable increase in the size of the indurated portion on inflation, probably because it was not possible to maintain a sufficient head of pressure. Inflation readily distended the remainder of the lobe, however, and localized prominence of the anterolateral aspect of the sub-apex suggested the possibility of underlying

FIG. 140.—Anteroposterior view showing the abnormal vessel and its branches outlined.

FIG. 142.—More or less comparable right lateral view with branches of abnormal vessel outlined. The fine vascular network in the anterior portion of the lobe comes from the added injection of a branch of the normal pulmonary artery to the lower lobe.

cystic emphysema. The partially inflated lobe showed a number of incomplete fissures.

The aberrant vessel entered the lung substance posteriorly at the junction of the mediastinal and diaphragmatic aspects.

The partially inflated lung was radiographed in the anteroposterior and right lateral projections with an adapter-nozzle in the bronchus and a probe in the abnormal artery. Comparable views were taken at a later stage after a radio-opaque pigment had been injected into the abnormal artery (*Figs.* 139–14[illegible]).

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A CASE OF RENO-INGUINAL FISTULA DUE TO PERIURETERIC ABSCESS

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RENO-INGUINAL fistula is a very uncommon condition and is usually due to a neglected perinephric abscess. A second but less common cause is a calculous pyonephrosis, either tuberculous or pyogenic in origin (Shucksmith, 1941).

The present case is of special interest in that in addition to the periureteric abscess which was surrounding a calculus situated in the upper third of the ureter, there was also a calculous pyonephrosis which was producing no symptoms. The *abscess had caused a perforation of the cæcum*, and it was this perforation that had produced the collection of pus below the right inguinal ligament.

CASE REPORT

Miss E. W., aged 58, was admitted into hospital complaining of œdema of the legs and weakness and loss of sensation in the anterior aspect of the right thigh. It was known that she was a diabetic and also had many large uterine fibroids, and it was thought that her condition was due to pressure from the fibroids together with a mild diabetic neuritis.

The following investigations were carried out :—

Electrocardiogram : Normal.

Blood count : White blood-cells 15,000/c.mm. ; red blood-cells 4,700,000/c.mm. ; hæmoglobin 80 per cent.

Wassermann reaction : Negative.

Urine : Culture, *Bacillus proteus* ; sugar, positive weak.

Chest X-ray : No abnormality detected.

A total hysterectomy was performed. At operation there was no evidence that the uterus, although large, was causing any direct pressure on the veins in the pelvis and no abnormality of the other abdominal organs was noted.

While she was convalescing from this operation she complained of a painful swelling in her right groin. On examination there was a tender indurated swelling, in the centre of which crepitus could be detected, situated below Poupart's ligament lateral to the femoral vessels. The right thigh showed some diminution of pain and touch sensation corresponding to a femoral nerve distribution, the quadriceps was weak, the knee-jerk absent, and the ankle-jerk diminished. The abdomen was normal apart from the recent incision, and neither kidney could be felt.

Further investigations were then undertaken :—

Straight X-ray of abdomen : "A branched calculus is situated in the right kidney. There is also some calcification below this but it is well placed forward and may be situated extra renal or in the lower pole of a large disorganized kidney."

Straight X-ray of groin : "A soft tissue shadow in the centre of which is a translucent area probably due to gas."

Intravenous pyelogram : "Normal left pyelogram. No function in the right kidney."

The following day the pain and swelling had increased and she had developed a pyrexia of 100·4°, obvious psoas spasm appeared and the white blood-cells had risen to 16,000/c.mm. A blood-film showed a polymorphonuclear leucocytosis with toxic granulations.

The swelling was then explored and about 1 c.c. of thick pus with a *B. coli* odour evacuated. A communication was discovered to lead to the retroperitoneal tissues, and a split drainage-tube was inserted for a distance of about 8 in.

Examination of the pus revealed the organisms to be mainly *B. coli* with some *B. proteus*.

Following drainage there was a marked improvement of the neurological signs. The femoral neuritis disappeared, the power in the quadriceps improved, and the knee-jerk returned. A copious discharge continued from the tube, which was irrigated with streptomycin 2 mg./c.c. On the fourth day after the operation fæces were first noticed in the discharge. After the appearance of the fæces a barium enema was given and it was discovered that there was a perforation in the cæcum. Not only did the barium appear in the groin, but barium was also clearly seen inside the psoas sheath.

A cystoscopy was then carried out. The bladder was full of pus and the mucous membrane very congested. Pus was also seen to be pouring from the right ureter. On inserting a ureteric catheter into the right ureteric orifice more pus appeared, but no obstruction to the passage of the catheter was encountered. On injecting sodium iodide up the catheter none appeared in the pelvi-caliceal system, but the opaque fluid escaped from the region of the lower area of calcification, and was seen spreading up and down the psoas sheath in a similar manner to the barium from the barium enema. As a result of these investigations a diagnosis of calculous pyonephrosis which had ruptured into the cæcum was made, and it was decided to explore the right kidney.

Pre-operatively the patient was given : (1) A course of succinyl sulphathiazole ; (2) Two pints of fresh blood ; (3) Streptomycin wash-outs, 2 mg./c.c. per rectum and also through the drainage-tube.

The kidney was then explored. It was firmly fixed by adhesions, particularly at the upper pole. No perinephric abscess was present but there was a closed calculous pyonephrosis ; the ureter was markedly thickened and adherent anteriorly to the cæcum, and appeared to contain a calculus in its upper part. The kidney pelvis was opened, the calculus removed, and a 'stump' nephrectomy carried out. The kidney was exceedingly difficult to remove, hence the 'stump' nephrectomy. (A 'stump' nephrectomy consists of ligating the bulky pedicle *en masse* and then cutting away the kidney substance, leaving sufficient tissue to hold the ligatures. All tissues distal to the ligature

subsequently slough, the only disadvantage of the operation being the somewhat prolonged period of drainage.)

It was at once apparent that the calculus in the upper part of the ureter had produced a periureteric abscess, which had in turn ulcerated into the cæcum. This further calculus was removed and the wound closed with drainage.

The wound rapidly healed and the patient was discharged a month after operation. Examination of the right thigh prior to discharge revealed still some diminution of sensation but normal motor power. No further cystoscopic examination was made before discharge; this subsequently proved to be an unfortunate omission.

The patient was re-admitted six months later with a history of painful frequency 3–4 hourly, day and night, hæmaturia, and the passage of large quantities of sediment.

On examination her general condition was good; she had put on half a stone in weight, her nephrectomy scar had soundly healed, and the sensation of the thigh had returned to normal.

The following investigations were carried out :—

Urine reaction: Markedly alkaline. Some R.B.C.s and many pus cells. Culture, *B. proteus*.

Intravenous pyelogram: Good function from remaining kidney. The bladder contains a foreign body 2½ in. in diameter, probably a calculus.

Cystoscopy: This revealed not a calculus but a pultaceous rounded mass approximately 3 in. in diameter which was adherent to the right lateral wall of the bladder. Apart from a mild generalized cystitis the rest of the bladder was normal.

As it was impossible to remove the mass per urethra, a suprapubic incision was made and the whole mass was removed by the transvesical route. On examination it contained a necrotic centre with a laminated outer covering, which proved to consist of inspissated fibrin.

Her post-operative course was uneventful and the wound rapidly healed. In the immediate post-operative period she was given 1 per cent acetic acid bladder washouts and large doses of ammonium chloride, together with a prolonged course of hexamine, in an attempt to keep the urine acid.

A further cystoscopy was carried out just prior to her discharge. A month after the removal of the mass of fibrin the bladder condition had much improved, but two small phosphatic plaques had commenced to re-form on the right lateral wall. These were dislodged by a ureteric catheter and washed out with acetic acid. Another cystoscopy was performed three months later. At this examination there was no sign of any deposit and the bladder mucosa had almost returned to normal.

Commentary.—This case is most unusual in that it presents an example of two conditions of extreme rarity.

In the first place, as a reno-inguinal fistula due to a periureteric abscess. The calculous pyonephrosis which was also present was an incidental finding, and it was only on careful interrogation after the radiograph had revealed the calculus that she admitted she had been treated for repeated attacks of cystitis, which had settled down under treatment from her family doctor.

Secondly, following her re-admission to hospital, she was discovered to have a large fibrin ball in the urinary bladder. Fibrin balls are found on occasions in the serous cavity, particularly the peritoneum, but in the urinary bladder they are rare, and Parkes Weber (1948) was only able to find 3 other examples in the literature. Its cause is unknown, but it is supposed that the fibrin is deposited from the urine on some central core, which in the present case was probably some calculus debris from the right ureter.

I should like to express my thanks to Mr. Cosbie Ross for permission to publish this case.

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REVIEWS AND NOTICES OF BOOKS

Principles and Practice of Surgery. By JACOB K. BERMAN, A.B., M.D., F.A.C.S., Associate Professor of Surgery, Indiana, University School of Medicine, Indianapolis. 6½ × 9½ in. Pp. 1378 + xvi, with 429 illustrations. 1950. London: Henry Kimpton. £5 5s.

ANOTHER book on surgery written by a single author! This is a Herculean task these days when so many branches of surgery have advanced so rapidly that no single man can keep abreast of them all. However, Professor Berman has made a gallant attempt to overcome the difficulties of the many and varied special branches of surgery and, indeed, the subjects of vascular surgery, thoracic surgery, and neurosurgery have been well covered. We are familiar with his former book *Synopsis of the Principles of Surgery*, and no doubt it was the popularity of this first work that encouraged him to attempt the present large volume.

We congratulate the author on the full coverage he has given to surgery in general and in the selection of his illustrations. Our one criticism is that the rare conditions in surgery are given greater prominence than the common ones; this applies not only to the text but to the illustrations as well. Why does any text-book require two whole-page photographs of children with congenital atresia of the common bile-duct? Although most of the illustrations are excellent and well chosen, yet some are very inaccurate. *Fig.* 398, illustrating the operation of subtotal thyroidectomy, depicts the inferior thyroid artery and the vein lying as single vessels inside the capsule of the thyroid gland. We have never seen such an arrangement before.

However, these are criticisms of not too grave a nature of a work which is otherwise of sound practical value. Professor Berman has used his vast clinical background to good effect in the writing of this large volume. The book will be read by surgeons and students who wish to extend their knowledge of the principles and practice of surgery.

A Companion to Manuals of Practical Anatomy. By E. B. JAMIESON, M.D., formerly Senior Demonstrator and Lecturer on Anatomy, University of Edinburgh. Seventh edition. 4⅛ × 6⅝ in. Pp. 736 + viii. 1950. London: Oxford University Press. 18s.

THOSE of us who have used *Cunningham's Manuals of Anatomy*, and the number must be many thousands, will welcome the new seventh edition of *Jamieson's Companion*.

The first edition of this useful Companion was published in 1913 and each subsequent edition has been reprinted often many times. These facts speak for themselves and prove the value and usefulness of this practical book. The lucid descriptions of complicated anatomical details are a joy to read.

Once more we would like to thank Dr. Jamieson for a most useful book.

Skull Fractures and Brain Injuries. By HARRY E. MOCK, M.D., Consulting Surgeon, St. Luke's Hospital, Chicago; Associate Professor Emeritus of Surgery, Northwestern University Medical School, Chicago. 6 × 9 in. Pp. 806 + xiv, with 116 illustrations. 1950. Baltimore: The Williams & Wilkins Co. (London: Baillière, Tindall & Cox.) 114s.

IN this mechanical age traumatic surgery has come to the fore and skull fractures and brain injuries are an ever increasing problem to the surgical profession. Motor-cycle and motor-car accidents probably head the list of general causative agents.

The second world war was a great stimulus to neuro-surgeons both at home and abroad and a new outlook on skull and brain injuries took place, and it was generally agreed that no injuries of the skull are so extensive as to be despaired of and none so slight as to be ignored.

In the past there was a tendency to treat the skull injury and neglect the underlying brain. To-day the reverse is the case. Professor Mock is quite right when he insists that " In all serious head injuries, with or without skull fractures, the management of the brain injury must be the first consideration ".

There are to-day few contra-indications to lumbar puncture following head injury—in fact it is often neglected to the detriment of the patient. Herniation of the brain into the foramen magnum is far more likely to occur following increased volume of the brain from injury than from lumbar puncture. This fact should be better known amongst the profession at large. Early lumbar puncture is not only of value from a diagnostic point of view but is a definite therapeutic procedure. Too often lumbar puncture is performed as a last resort in head injuries, and failure ensues.

This book contains the clinical acumen of a surgeon who has had an extended experience of head injuries, and his advice and teaching are sound and practical.

It is to be hoped that those surgeons who do not often treat head injuries will read this book, because by so doing they will acquire sound knowledge which must benefit their patients.

The Abnormal Pneumoencephalogram. By LEO M. DAVIDOFF, M.D., Director of Neurological Surgery, Beth Israel Hospital, New York City; Clinical Professor of Neurosurgery, New York University Post-graduate Medical School; and BERNARD S. EPSTEIN, M.D., Associate Radiologist, The Jewish Hospital of Brooklyn, Brooklyn, N.Y., and Instructor in Clinical Radiology, Long Island College of Medicine. 7½ × 10½ in. Pp. 506, with 289 illustrations. 1951. London: Henry Kimpton. 105s.

IT is interesting to note that the authors of the monograph on *The Normal Encephalogram* should now produce its counterpart on the abnormal pneumo-encephalogram. Also that the year 1950 marks the thirty-second anniversary of the introduction of pneumo-encephalography in the diagnosis of neurological disease.

It may be said that encephalography is one of the greatest aids that the neurosurgeon has to-day in the diagnosis of cerebral conditions. The great advantage of encephalography over ventriculography is that the former does not necessitate an operation on the skull.

This monograph is superbly reproduced and lavishly illustrated with excellent radiographs and pathological specimens. It is the outcome of prolonged clinical experience and the co-operation between a neurosurgeon and a radiologist.

We predict that no surgeon, neurologist, or radiologist can afford to be without this excellent monograph, for it gives an amazing amount of information that cannot be found elsewhere. An excellent production.

Royal Northern Operative Surgery. By the Surgical Staff of the Royal Northern Hospital. Second edition. Edited by Sir LANCELOT BARRINGTON-WARD, K.C.V.O. 6½ × 9¾ in. Pp. 638 + viii, with 498 illustrations, some coloured. 1951. London: H. K. Lewis & Co. 90s.

THE second edition of this truly British volume of operative surgery has been too long delayed, but now that it has appeared there can be no doubt that it is the best one-volume book on operative technique in the English language. Sir Lancelot Barrington-Ward has managed his team of colleagues in a masterly manner, so that all that has been found of value in the various operations performed on the human body has been incorporated in this book. New chapters on Plastic and Neurosurgery have been added.

Perhaps the best attribute of the book is the fact that each chapter has been written by a surgeon of matured experience and that every operation described has been accepted by surgeons both at home and overseas. There is not a multiplicity of operations for any one condition, but the best and most practical one is described.

A great feature of the book is the high standard of its many illustrations; some of these are in colour and depict the clinical condition admirably.

An excellent production which upholds the best in British surgery.

Royal College of Surgeons of England: A record of the year from 1901 to 1951. Pp. 79, with 14 illustrations. 1951. Published by the Royal College of Surgeons of England, Lincolns Inn Fields, London. 5s.

ON March 22, 1800, The Company of Surgeons was re-incorporated and constituted by the name of The Royal College of Surgeons in London, by a Charter granted by George III. The Hunterian collection had been purchased by the Nation for £15,000 and under an Order of the Treasury was entrusted to the Company on November 28, 1799.

In the year 1806 Parliament voted a sum of £15,000, and subsequently a further sum of £12,500, in aid of the erection of a building for the display of the Hunterian Collection and at the same time a sum of £21,000 was added from the funds of the College. The museum was opened to visitors in 1813.

In 1843 Her Majesty Queen Victoria granted another Charter whereby the title was changed to that of The Royal College of Surgeons of England. Such is very briefly the inception of the Royal College of Surgeons as we now know it.

In the Foreword to the present volume Sir Cecil Wakeley states that " At the time of the centenary celebrations in 1900, the President, Sir William MacCormac, published two memorial volumes. One contained a history of the domestic activities of the College during the previous century " and the other " the Address of welcome which he had pronounced before H.R.H. The Prince of Wales (King Edward VII) and the delegates and guests at the celebrations ". The address was a short history of surgery and particularly the advances achieved during the nineteenth century, and to it he appended a short biography of all the Masters and Presidents of the College since the re-incorporation in

1800. The title of Master was changed to President by a supplementary Charter granted by George IV in 1821.

It was a happy inspiration of the President, Sir Cecil Wakeley, that at the close of the third half century and during the " Festival of Britain " year the College should publish, for the Fellows, Members, and many friends of the College, a brief description of the history and activities of the College from 1901 to 1951, and append to it a brief biography of those who have occupied the high office of President of the College during that period.

Their activities in maintaining the progress of surgery will be appreciated when these biographies are read.

The brief history of the College since 1901 occupies the first twenty pages and is the work of the Secretary, Mr. Kennedy Cassels, and the librarian, Mr. W. R. Le Fanu. It summarizes the activities of the College with regard to British surgery in general, and more particularly to the steady development which has taken place in order to offer the greatest facilities for post-graduate study in the basic sciences, culminating in the foundation of the Nuffield College of Surgical Sciences, which has been achieved by the munificent gift of a quarter of a million by Lord Nuffield. " Arrangements and negotiations are at present being made to form and develop an Institute of the Basic Medical Sciences at the College in connexion with the University of London."

The College of Surgical Sciences, where the students have residential accomodation, is unique, and ultimately about 100 students will be in residence. It will be a boon to post-graduate students in surgery coming to London from the Commonwealth, the Dominions, and other countries, and will give them the great advantage of collegiate life, and the opportunity of attending any of the many lectures which are given at the College by well-known surgeons from various parts of Great Britain and other parts of the world, and those given from year to year by carefully selected Hunterian professors, as well as those in surgery and allied subjects arranged from time to time by the post-graduate Dean and Committee. They may even personally meet, talk, and dine with those whose names, in after years, they will regard as household words in surgery. The social amenities offered by the College will promote good and friendly relations between all Fellows and Members and do much to cement the reciprocity between the Royal Colleges of Surgeons in every English-speaking country throughout the world.

The immense changes which have taken place during the last century with regard to the relations between the medical profession and the State are indicated, and the leading part which the Royal College of Surgeons and its sister Colleges have played in the negotiations are implied. When one comes to read the biographies of the sixteen surgeons who have occupied the Presidential Chair since 1900, it will be appreciated with what self-sacrifice they have devoted themselves to the duties of their office. With such a number it must necessarily be that some have had perhaps greater opportunities than others or been endowed with wider vision of the future possibilities in the work of the College, but it will be agreed that all have given of their best. Those who appear to have achieved more have had the good fortune to have erected a superstructure on the foundation laid by their predecessors. The names that will occur to the reader will be those mentioned in the President's Foreword—namely, Lord Moynihan and Lord Webb-Johnson, who between them served the College as President for fourteen years. This is a book which every Fellow and Member should possess and be proud to have in his library, and would be justified in showing to his or her friends to demonstrate what has been done by his or her College in the past half century; since the tragic night of May 10, 1941, when all seemed lost, how, by the munificence of generous donors and the untiring work and wisdom of the President, Lord Webb-Johnson, and the Council, their College is rising phœnix-like from the ruins of warfare.

One can only echo the words of Her Majesty the Queen when she graciously accepted and received the Honorary Fellowship: " I feel I can congratulate the College with confidence because the traditions on which its great reputation rests are stronger and more precious than ever, and have, moreover, become a part of the national life ".

We know the tradition; it is the duty of all Fellows and Members to maintain and enhance it.

Modern Surgery for Nurses. Edited by F. WILSON HARLOW, M.B., F.R.C.S. (Eng.). With a Foreword by SIR LANCELOT E. BARRINGTON-WARD, K.C.V.O., F.R.C.S. Second edition. $5\frac{1}{2} \times 8\frac{1}{2}$ in. Pp. 799 + xxiv, with 429 illustrations. 1951. London: William Heinemann Medical Books Ltd. 25s.

SIR LANCELOT BARRINGTON-WARD wisely states in the Foreword that the burden of knowledge to be assumed by a nurse is somewhat intimidating. A book of 799 pages (a considerable portion of which is in small print) is unlikely to soothe her apprehension, and much of the material is far more advanced than that required for the final examination. Thus the six radiographs of a deformed duodenal cap (*Fig.* 144) can be but a puzzle to a nurse, and the anatomical details of hernia operations (*Fig.* 163) are another unnecessary worry. Some statements require correction, e.g., Sclavo's serum (p. 129) is obsolete, saline is not now recommended for shock (p. 670), and the latest returns for the mortality of acute appendicitis (p. 190), are less than 1,500 per annum.

However, much of the material is excellent, and useful details are given concerning diets and simple remedies, though it is doubtful if asafœtida enemata are now prescribed. This is a valuable reference book for Tutors, Theatre Sisters, and senior nurses, but it is more likely to frighten than to attract a student nurse, whose time should be fully occupied in grasping the essentials of practical surgical nursing.

1950 Year Book of Orthopedics and Traumatic Surgery. Edited by EDWARD L. COMPERE, M.D., F.A.C.S., Associate Professor of Bone and Joint Surgery, Northwestern University Medical School, Chicago. $5 \times 7\frac{3}{4}$ in. Pp. 388, with 264 illustrations. 1951. Chicago: Year Book Publishers Inc. $5.00.

ALTHOUGH there have not been any spectacular advances in orthopædic surgery during the last year, yet certain changes are taking place. Osteomyelitis is a disappearing disease, and dyschondroplasia, at one time thought to be the result of primary germ-cell defects, is now known to be a vitamin-D-resistant type of rickets. Streptomycin is now known to be extremely valuable in the treatment of bone and joint tuberculosis.

These and many other trends are clearly brought out in this excellent book which gives a précis of all the important contributions to orthopædic and traumatic surgery during the last year.

A Complete Outline of Fractures. Including Fractures of the Skull. By J. GRANT BONNIN, M.B., B.S. (Melbourne), F.R.C.S. (Eng.), Orthopædic Surgeon, Central Middlesex Hospital. Third edition. $5\frac{1}{2} \times 8\frac{3}{4}$ in. Pp. 671 + xiv, with 710 illustrations. 1951. London: William Heinemann Medical Books Ltd. 42s.

THE third edition of this work differs from the second in containing more illustrations, a section on fractures of the face and jaw, and further information on the operative treatment of fractures, with details of the latest antibiotics. It offers the undergraduate, in one 700-page volume, an

introduction to fractures and trauma in general which is excellent for several reasons: basic principles and references are clearly presented, and rarities are avoided; there is sufficient practical detail for the most inexperienced; and most of the current views on aetiology, pathology, and treatment are quoted, without loss of the author's authoritative guidance, which is sound throughout. As might be expected, the section devoted to injuries in the region of the ankle-joint reflects the author's special interest in this subject, and most postgraduate students would be well repaid by reading it.

The book as a whole is well balanced and readable.

World Surgery, 1950. By STEPHEN A. ZIEMAN, M.A., M.D., F.A.C.S., F.I.C.S., Abstract and News Editor, Journal of the International College of Surgeons. 8½ × 11 in. Pp. 177 + xii, with 52 illustrations. 1950. Philadelphia and London: J. B. Lippincott Co. 50s.

IT is difficult to know why this volume was written, because it gives a series of abstracts of articles on general surgical subjects which are all covered in many of the good abstracting journals which have been published for many years.

The author considers that the volume is a survey of the world literature in surgery, but it is not so comprehensive or so useful as the *Year Book of Surgery*.

Max Thorek, who writes a Foreword to this book, considers that it meets a need not filled by the conventional text-book, or the specialized manual of surgical technique. We consider that all the abstracted material in this book can be found in " Surgical Abstracts ".

Pedicle Flaps in Plastic Surgery of the Head and Neck. By GORDON B. NEW, M.D., F.A.C.S., Professor of Plastic Surgery, and JOHN D. ERICH, M.D., F.A.C.S., Associate Professor of Plastic Surgery, Graduate School, University of Minnesota, Minneapolis. 6 × 9 in. Pp. 104 + vii, with 76 illustrations. Springfield, Ill.: Charles C. Thomas. (Oxford: Blackwell Scientific Publications Ltd.) 21s. 6d.

THE surgery of repair is based on two architectural principles: First, the transplantation of tissue attached by means of a root or pedicle which carries its own blood-supply at all times during the period of transfer, and, secondly, the free transplantation of tissue from a donor to a recipient site bereft of its original blood circulation. These two principles, from the times of Susruta, the Brancas, the Vinaneo Brothers, and especially of Gaspare Tagliacozzi, have been classically developed in terms of skin, but in their modern conception now include any tissue used in reconstructive surgery whether it be skin, fat, fascia, muscle, cornea, cartilage, or bone. This monograph from the Mayo Clinic deals with one aspect of the first and more difficult of these two principles, and applies it to the limited field of the head and neck. The authors' classification of pedicled skin-flaps is an arbitrary one and would not find universal acceptance, but it is at least practical and simple. One based on the functional aspect of maximum movement in specific directions consistent with maximum blood-supply at the extreme range of transfer would perhaps have had more value.

Sixteen pedicled skin-flaps of different types are described and the indications for each one given, together with the advantages and disadvantages in a variety of facial skin losses. The authors have not enlivened their text with any of the rich historical background which surrounds the subject, and indeed the only historical reference in the entire book is an erroneous one. Apart from this, however, the book contains a wealth of sound teaching based on the authors' wide experience.

It should do much to clarify some of the confusion which exists among those who cannot, in the plastic field, distinguish between a technical method and a fundamental principle.

The Life and Times of Gaspare Tagliacozzi, Surgeon of Bologna, 1545–1599. By MARTHA TEACH GNUDI and JEROME PIERCE WEBSTER. New York: Herbert Reichner. Quarto. Pp. 538 + xxii. 1950. Limited edition. $15.00.

PLASTIC surgery is believed to have had its origin in remote times in India; but the first book devoted to the subject was published in Venice in 1597 under the title, *De curtorum chirurgia per insitionem*. The author, Gaspare Tagliacozzi, was the first surgeon to establish a reputation in this specialty and is properly regarded as the father of what is now a very important branch of surgery. He was born and educated at Bologna, graduating in 1570. At the age of 25 he had already achieved distinction as an anatomist and was soon appointed a teacher of surgery. From early times mutilation had been the punishment awarded to malefactors, such as adultresses and thieves, and in sixteenth-century Italy injuries to the face were frequently inflicted in personal combat and family feuds. Noses were also lost by venereal disease, and so disfigurement might afflict the highest nobility as well as the common man. There were therefore many opportunities for the practice of reconstructive surgery, chiefly in the repair of ears, lips, and noses, and Tagliacozzi developed his skill in this field to such a degree that after his death in 1599 he was accused of having practised the black arts. As he had been buried within the precincts of a nunnery, his remains were exhumed and taken elsewhere, though ultimately his innocence was vindicated; and his memory has been held in great honour to the present day. Other writers, such as Paré and Fallopius, had dealt very inadequately with the principles of plastic surgery, and Tagliacozzi's folio treatise, finely illustrated, was long to remain the classical account of the subject. The first adequate summary of his work to appear in English was that published by Alexander Read in his *Chirurgorum comes*, London, 1687.

As a pioneer in plastic surgery and as the author of the first treatise on the subject, Tagliacozzi has naturally attracted the attention of medical historians, and his early editions have become expensive items in the antiquarian book market. Nevertheless it has been left to Professor Webster, of Columbia University, himself a very distinguished plastic surgeon, to write fully and adequately of the life and achievements of his great predecessor. Professor Webster has collaborated with Dr. Martha Gnudi, a student of Italian letters as well as of medical history, and together they have produced a piece of historical research which, as a monument to the memory of Tagliacozzi, is never likely to be superseded. The authors have devoted many years of labour to their task, particularly to the study of documents in Italian archives, with the result that many new facts have been found and earlier errors corrected, and Tagliacozzi's place in medical history has been finally established. Few details can have been overlooked, even the history of the Tagliacozzi family having been examined over a period of 250 years. The history of plastic surgery is carried both backwards and forwards from Tagliacozzi's time, so that the volume forms a comprehensive study of the whole subject. A large number of relevant documents are printed in full, and the whole work is superbly illustrated. The only defect that can be noticed is the absence of scientific collations of the editions of *De curtorem chirurgia*, so that collectors and librarians still have no means of ascertaining whether the copies in their possession are complete or not. In every other respect the volume, printed and produced in Italy, is deserving of the highest praise.

Studies in Pathology. Presented to Peter MacCallum. Edited by E. S. J. KING, T. E. LOWE, and L. B. COX, Melbourne. 5½ × 8⅝ in. Pp. 350 + xii, with 42 plates and line illustrations in text. 1950. Melbourne: University Press. (London: Cambridge Press.) 35s.

THIS volume is made up of a series of studies in pathology contributed by associates and students of Professor P. MacCullum, of Melbourne University, and the book was presented to him on his sixty-fifth birthday.

The various studies cover a wide field and many of them are of great interest to surgeons. Professor G. R. Cameron contributes a very fascinating article on the normal and pathological patterns in the liver. R. A. Willis writes on metaplasia, and succeeds in interesting the reader in a difficult yet important subject. Reginald Webster discusses the phases of tuberculosis in childhood, while W. McI. Rose deals with infants in a very lucid and practical manner.

Other articles include excellent accounts of the relation of Pathology to Surgery in regard to the œsophagus and lung. Special groups of observations include Visceral Changes in Rheumatoid Arthritis, Glycogen in the Liver, Hæmosiderosis and the relation of Congenital Heart Disease and Rubella.

The wide range of subjects is an indication of the breadth of outlook and teaching of Professor MacCallum.

Each article is followed by up-to-date references, and the whole volume is well produced and the illustrations are excellent. A book to read and re-read.

BOOK NOTICES

Micro-arteriography. And other Radiological Techniques employed in Biological Research. By ALFRED E. BARCLAY, O.B.E., M.D., D.Sc. (Hon.), F.R.C.P., F.F.R., F.A.C.R., Honorary Radiologist to the Nuffield Institute for Medical Research, Oxford. 7⅜ × 9½ in. Pp. 102 + xiv, with 46 illustrations. 1951. Oxford: Blackwell Scientific Publications. 30s.

Clinical Uses of Intravenous Procaine. By DAVID J. GRAUBARD, M.D., New York, and MILTON C. PETERSEN, M.D., Missouri. British Commonwealth Edition edited by WILLIAM W. MUSHIN, F.F.A., R.C.S., D.A., Director, Department of Anæsthesia, Welsh National School of Medicine, Cardiff. 5½ × 8½ in. Pp. 84 + xii, with 9 illustrations. 1951. Oxford: Blackwell Scientific Publications. 8s. 6d.

1950 Year Book of Neurology, Psychiatry and Neurosurgery. Edited by ROLAND P. MACKAY, M.D., Professor of Neurology, University of Illinois (Neurology); NOLAN D. C. LEWIS, M.D., Director N.Y. State Psychiatric Institute and Hospital (Psychiatry); and PERCIVAL BAILEY, M.D., Professor of Neurology and Neurological Surgery, University of Illinois. 5 × 7⅝ in. Pp. 627, with 121 illustrations. 1951. Chicago: Year Book Publishers Inc. $5.00.

L'Anesthésie facilitée par les Syringies medicamentenses. By H. LABORIT, Chirurgien des Hôpitaux Maritimes. 6¼ × 8¾ in. Pp. 120, with 6 illustrations. 1951. Paris: Masson et Cie. 500 fr.

Studies in Lobotomy. Edited by MILTON GREENBLATT, M.D., ROBERT ARNOT, M.D., HARRY C. SOLOMON, M.D., Harvard Medical School. 6 × 9 in. Pp. 495 + xii, with numerous illustrations. 1951. London: William Heinemann Medical Books Ltd. 63s.

Psychosurgery. In the Treatment of Mental Disorders and Intractable Pain. By WALTER FREEMAN, M.D., Ph.D., F.A.C.P., and JAMES J. WATTS, M.D., F.A.C.S., F.I.C.S., Washington, D.C. Second edition. 6½ × 10 in. Pp. 598 + xxx, with 160 illustrations. 1951. Springfield, Ill.: Charles C. Thomas. (Oxford: Blackwell Scientific Publications.) 77s. 6d.

The Organization of Bones. By P. LACROIX, Professor in the Faculty of Medicine, University of Lorain. Translated from the amended French edition by STEWART GILDER, B.Sc., M.B. 5⅜ × 8⅜ in. Pp. 235 + viii, with 87 illustrations. 1951. London: J. & A. Churchill Ltd. 25s.

Official Transactions of the Twenty-fourth Meeting of the Northern Surgical Association. Held in Helsingfors, June 28–30, 1949. Edited by Prof. E. DAHL-IVERSEN, M.D., Secretary-General. 6¼ × 9¾ in. Pp. 365 + xvi. 1950. Copenhagen: Ejnar Munksgaard.

Introduction to Surgery. By VIRGINA KNEELAND FRANTZ, M.D., Associate Professor of Surgery, Columbia University; and HAROLD DORTIC HARVEY, M.D., Assistant Professor of Clinical Surgery, Columbia University. Second edition. 4¾ × 7¼ in. Pp. 233 + xii, with 12 illustrations. 1951. New York: Oxford University Press. (London: Geoffrey Cumberlege.) 21s.

Cancer of the Colon and Rectum. Its Diagnosis and Treatment. By FRED W. RANKIN, B.A., M.A., M.D., LL.D., Sc.D., F.A.C.S., and A. STEPHENS GRAHAM, M.D., M.S., F.A.C.S. Second edition. 6 × 9¼ in. Pp. 427 + xiv, with 148 illustrations. 1951. Springfield, Ill.: Charles C. Thomas. (Oxford: Blackwell Scientific Publications.) 55s.

Surgical Nursing and After-treatment. By H. C. RUTHERFORD DARLING, M.D., M.S., F.R.C.S., F.R.F.P.S. Glasg., Surgeon, Prince Henry Hospital and New South Wales Masonic Hospital, Sydney, N.S.W., and T. EDWARD WILSON, M.D., M.S., M.Sc., F.R.C.S., F.A.C.S., F.R.A.C.S., Assistant Surgeon, The St. George Hospital, Sydney. Tenth edition. 4¾ × 7¼ in. Pp. 630 + x, with 188 illustrations. 1951. London: J. & A. Churchill Ltd. 16s.

The Essentials of Modern Surgery. Edited by R. M. HANDFIELD JONES, M.C., M.S., F.R.C.S., Senior Surgeon to St. Mary's Hospital; etc.; and SIR ARTHUR E. PORRITT, K.C.M.G., C.B.E., M.A., M.Ch., F.R.C.S., Surgeon to H.M. The King, Surgeon, St. Mary's Hospital; etc. Fourth edition. 6 × 9⅝ in. Pp. 1263 + xv, with 641 illustrations. 1951. Edinburgh: E. & S. Livingstone. 55s.

The Normal Encephalogram. By LEO M. DAVIDOFF, M.D., Director of Neurological Surgery, Beth Israel Hospital, New York City; and Cornelius G. Dyke, M.D., Late Associate Professor of Radiology, Columbia University. Third edition, revised by LEO M. DAVIDOFF. 6 × 9 in. Pp. 240, with 156 illustrations. 1951. London: Henry Kimpton. 42s.

Acute Head Injury. By JOSEPH P. EVANS, M.D., Ph.D., Associate Professor of Surgery, University of Cincinnati College of Medicine, Ohio. Pp. 116 + v. 1951. Illinois: Charles C. Thomas. (Oxford: Blackwell Scientific Publications Ltd.) 16s. 6d.

Primary Carcinoma of the Liver. A study in Incidence, Clinical Manifestations, Pathology and Aetiology. By CHARLES BERMAN, M.D., B.Ch. Rand. Senior Medical Officer, Consolidated Main Reef Mines and Estate Ltd., Maraisburg, Transvaal, S.A. With a Foreword by SIR ERNEST KENNAWAY. 7¼ × 9¾ in. Pp. 164 + xvi, with 83 illustrations. 1951. London: H. K. Lewis & Co. Ltd. 35s.